Felger, R.S., S. Rutman, C.M. Guilliams, and J. Malusa. 2015. Ajo Peak to Tinajas Altas: A flora of southwestern Arizona: Part 10. Eudicots: Berberidaceae, Bignoniaceae, and Boraginaceae. Phytoneuron 2015-1: 1–60. Published 7 January 2015. ISSN 2153 733X.

AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 10. EUDICOTS: BERBERIDACEAE, BIGNONIACEAE, AND BORAGINACEAE

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ABSTRACT

A floristic account is provided for three eudicot families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the heart of the Sonoran Desert of southwestern Arizona: Berberidaceae with 2 species, Bignoniaceae with 1 species, and Boraginaceae sensu lato with 34 modern species plus one fossil species no longer present. Among the 3 families, at least 13 of these species are also known from fossils recovered from Ice Age packrat (*Neotoma*) middens. This is the tenth contribution for this flora, published in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium (ARIZ).

This contribution to our flora in southwestern Arizona (Figure 1) is the tenth published in a series in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium (ARIZ). Three eudicot families are included in this contribution: Berberidaceae (1 genus with 2 species, and at least 1 species represented by fossils); Bignoniaceae (1 genus with 1 species), and Boraginaceae sensu lato (14 genera with 35 species, including 12 species represented by fossils). (Table 1). There are no non-native taxa in the flora area among the 3 families.

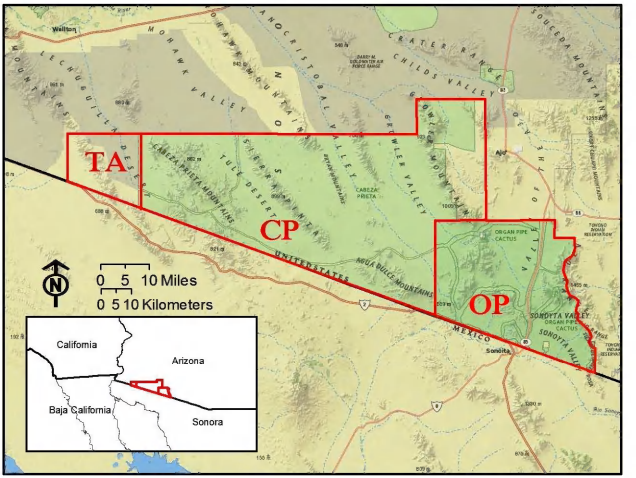

Figure 1. Flora area in southwestern Arizona. TA = Tinajas Altas. CP = Cabeza Prieta NWR. OP = Organ Pipe Cactus NM. Green shading indicates approximate boundary of federally designated wilderness.

Family designations follow APG III (Angiosperm Phylogeny Group 2009; also see Stevens 2001). Fossil specimens are indicated with a dagger symbol (†) and the one fossil taxon no longer present in the flora area is marked with two dagger symbols (††). In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish, and the Hia C-ed O'odham dialect, respectively (Spanish-language names are italicized). The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that such quantitative values are, to varying degrees, seldom exact. The identification keys are for the modern flora.

All photos and scans are by Sue Rutman unless otherwise stated. Photos of borage floral parts and nutlets are by Michael G. Simpson and students, San Diego State University (www.sci.sdsu.edu/plants/boraginaceae). All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2013). We have seen specimens or images of all specimen cited. When no collection number is provided, the specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, TA = Tinajas Altas Region (Figure 1). Additional explanation of the format for this flora series is provided in part 3 (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

Table 1. Local distributions and growth forms of Berberidaceae, Bignoniaceae, and Boraginaceae for the flora in southwestern Arizona. † = Modern taxa also represented by a fossil specimen(s), †† = fossil taxon no longer present in the flora area (not counted in the totals). OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, TA = Tinajas Altas Region. SU = Summer/warm season ephemerals, WI = cool-season/winter-spring ephemerals, AP = facultative annuals or perennials, and PR = perennials.

Taxon	Region			Growth Form			
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Ephemerals		Facultative annual or perennial	Perennial
				Summer	Winter		
BERBERIDACEAE							
†*Berberis haematocarpa*	OP						PR
Berberis harrisoniana	OP						PR
†*Berberis* sp.	(OP)						(PR)
BIGNONIACEAE							
Chilopsis linearis	OP	CP					PR
BORAGINACEAE							
†*Amsinckia intermedia*	OP	CP	TA		WI		
†*Amsinckia tessellata*	OP	CP	TA		WI		
†*Cryptantha barbigera*	OP	CP	TA		WI		
Cryptantha ganderi		CP			WI		
†*Cryptantha maritima*	OP	CP	TA		WI		
†*Cryptantha pterocarya*	OP	CP	TA		WI		
††*Cryptantha utahensis*			(TA)		(WI)		
Eremocarya micrantha		CP			WI		
Eucrypta chrysanthemifolia	OP	CP			WI		
Eucrypta micrantha	OP	CP	TA		WI		
Harpagonella palmeri	OP				WI		
Heliotropium curassavicum	OP	CP					PR
Johnstonella angustifolia	OP	CP	TA		WI		
Johnstonella holoptera		CP				AP	
†*Johnstonella racemosa*		CP	TA			AP	
†*Lappula occidentalis*	OP	CP			WI		
Nama demissum		CP	TA		WI		
Nama hispidum	OP	CP	TA		WI		
†*Pectocarya heterocarpa*	OP	CP	TA		WI		
†*Pectocarya platycarpa*	OP	CP			WI		
Pectocarya recurvata	OP	CP			WI		
Phacelia affinis	OP				WI		
Phacelia bombycina		CP			WI		
Phacelia coerulea	OP	CP			WI		
†*Phacelia crenulata*	OP	CP	TA		WI		
Phacelia distans	OP	CP			WI		
Phacelia neglecta	OP	CP	TA		WI		
Phacelia pedicellata	OP	CP	TA		WI		
Phacelia ramosissima	OP						PR
Phacelia rotundifolia	OP				WI		
Pholistoma auritum	OP	CP			WI		
†*Plagiobothrys arizonicus*	OP				WI		
Plagiobothrys jonesii	OP				WI		
Tiquilia canescens	OP	CP					PR
Tiquilia palmeri		CP	TA				PR
Totals for Boraginaceae:	**27**	**28**	**16**	**0**	**28**	**2**	**4**

BERBERIDACEAE – Barberry Family

Worldwide, mostly north temperate; 15 genera with 650 species.

Berberis – Barberry

The two species in the flora area are woody shrubs with rigid branches and bright yellow inner bark and wood. Mostly evergreen; leaves with prominent petioles, odd pinnate or 3-foliolate, the leaflets firm with large, spine-tipped teeth. Inflorescences (those in the flora area) of small, few-flowered racemes, the flowers bright yellow to yellow-orange, small, and 3-merous with 9 sepals in 3 whorls (the 3 outer ones also known as bracteoles) and 6 petals in 2 whorls, the petals nectiferous. Stamens 6, tactile (closing inward when touched), the anthers opening by 2 apical valves. Fruits of few-seeded berries, juicy and edible.

Shrubs of the two species occur at higher elevations in the Ajo Mountains, and in some parts of Alamo Canyon they grow next to each other.

This genus is nearly worldwide with 500 species, with very few in deserts.

1. Leaflets mostly 5 or 7, conspicuously glaucous; berries reddish at maturity. ..... **Berberis haematocarpa**
1. Leaflets 3, not glaucous; berries blue-black at maturity..... **Berberis harrisoniana**

Berberis haematocarpa Wooton
[*Mahonia haematocarpa* (Wooton) Fedde]
Red barberry. Figure 2.

Shrubs 1–2.5 m tall; bark rough and fissured. Leaves mostly evergreen, 4–10+ cm long, the leaflets (3) 5 or 7 (9), bluish glaucous, the terminal leaflet longest and often stalked. Sepals yellow, the petals yellow-orange. Berries 6–8 mm in diameter, reddish purple. Flowering winter and early spring, the fruits ripe in April.

Common at higher elevations in the Ajo Mountains, and present in these mountains for more than 13,500 years. The nearest population is isolated on Sierra Pinacate above 800 m.

Arizona to western Texas, southeastern California, southern Nevada, Colorado, and northern Sonora and Chihuahua; often in oak woodland and chaparral.

OP: Alamo Canyon: 18 Dec 1939, *Harbison 26268* (SD); 9 Mar 1946, *Goodding A-13-46*; upper reaches of canyon, sepals light yellow-green, petals orange, 30 Mar 1988, *Baker 7600* (ASU). Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 536*. †Montezuma's Head, leaflets, seeds, 13,500 ybp.

Berberis harrisoniana Kearney & Peebles
Kofa Mountain barberry. Figure 3.

Shrubs to 3 m tall. Leaves mostly evergreen, 4–11.5 cm long, the leaflets 3, sessile, all alike or the terminal one largest, green to yellow-green, not glaucous; leaflets including the margins and spines are thicker than those of *B. haematocarpa*. Flowers apparently monochromatic, yellow to apparently darker (yellow-orange) with age. Berries 5–6 mm in diameter, bluish black. Flowering January and February (March), the fruiting March and April (May).

Ajo Mountains; canyons and cliff bases at higher elevations. It has been in the Ajo Mountains for at least 9600 years.

Documented otherwise from only three other isolated desert ranges: the Sand Tank Mountains in Maricopa County, the Kofa Mountains in Yuma County, and southeastern California in the Whipple Mountains. "Typical habitat is talus slopes and among bases of sheer cliffs, and canyons between 760 and 1100 m. These microsites are generally shady with northern exposure and more mesic than the surrounding desert. ... [It] is a relict species related to *B. trifoliolata* Moricand from southeastern Arizona, New Mexico, and Texas" (Anderson & De Groot 2004: 395; also see Arizona Rare Plant Committee 2001).

OP: Pitahaya Canyon, 3400 ft, *Nichol* 23 Feb 1939. Above Pitahaya Canyon, mesic area above base of W face of Montezuma's Head, 3400 ft, 16 Jan 1976, *Phillips 76-2*. Arch Canyon: S of arch, 3400 ft, deep shaded canyon, wide crack in N facing cliff, 18 Feb 1978, *Fay 738*; Shrub to 3 m, mostly shaded by east-facing steep slopes, 950–1000 m, 12 May 1988, *Baker 7611* (ASU, ORPI). Trail from Bull Pasture to crestline, above The Cones, 32º00.84'N, 112º41.06'W (NAD 27), 4025 ft, 9 Apr 2005, *Felger* (observation). †Alamo Canyon, leaf fragments, seeds, 9570 ybp (very common).

Figure 2. *Berberis haematocarpa*. Middle fork of Alamo Canyon, 24 Mar 2008.

Figure 3. *Berberis harrisoniana*. Estes Canyon, trail to Bull Pasture: (A & B) 30 Jan 2014; (C) note the two shrubs at base of cliff, 10 Apr 2005.

†Berberis sp.

Ice Age midden samples from the Ajo Mountains, not identifiable to species, are probably one or both of the present-day species. Some barberries occur today near all of the midden sites.

OP: †Alamo Canyon, leaflet fragments, seeds, 8130 to 29,110 ybp (4 samples). Montezuma's Head, leaflet fragments, seeds, 17,830 to 21,840 ybp (3 samples).

BIGNONIACEAE – Bignonia Family

This family of about 120 genera and more than 700 species is worldwide, mostly in the tropics and subtropics with relatively few in deserts. *Chilopsis* has a single species.

Chilopsis linearis (Cavanilles) Sweet subsp. **arcuata** (Fosberg) Henrickson
Desert willow; *mimbre*. Figure 4.

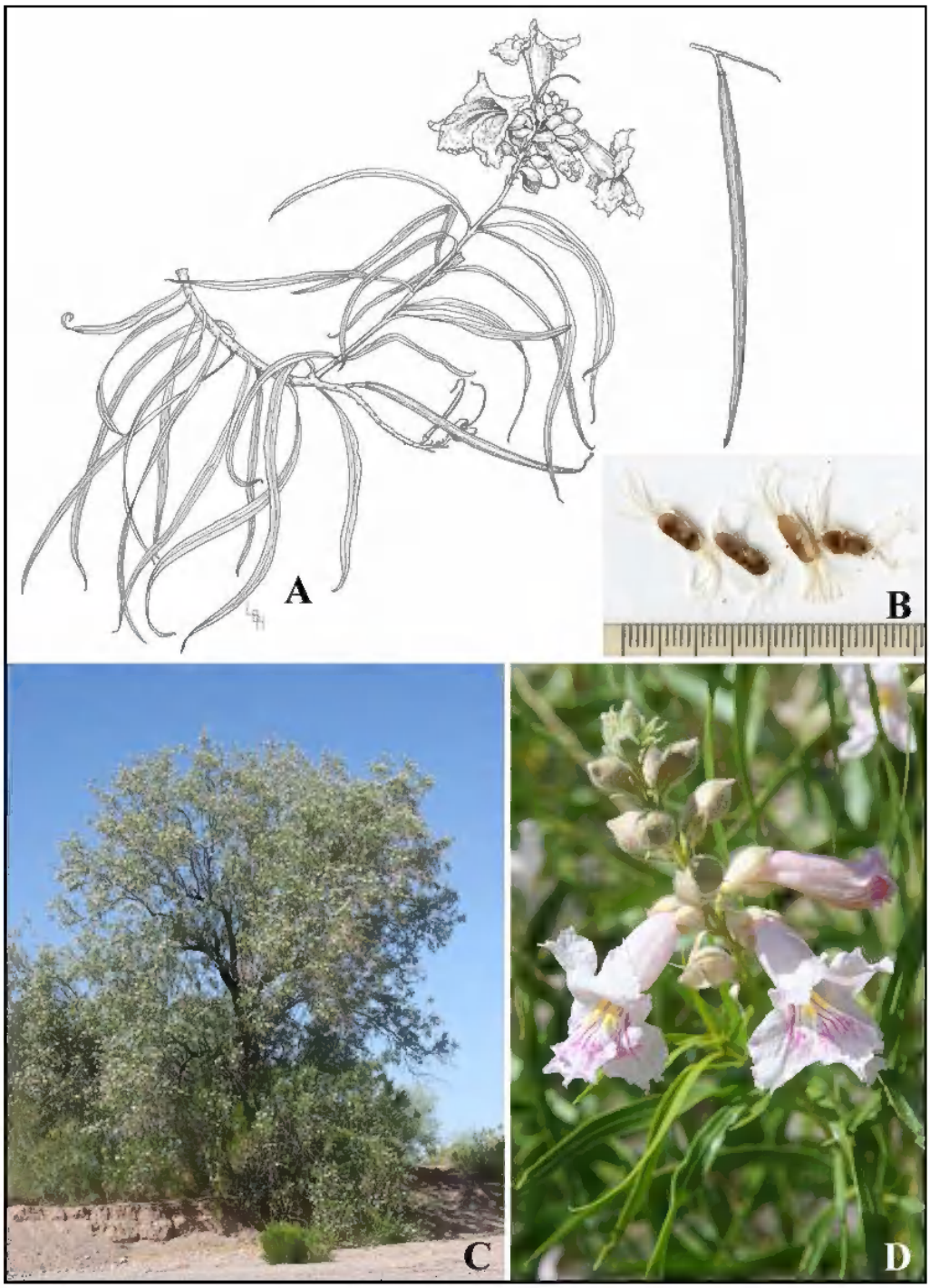

Figure 4. *Chilopsis linearis* subsp. *arcuata*. (A) By Lucretia Breazeale Hamilton. Gunsight Wash near Hwy 85: (B) Seeds, 1 Aug 2014; (C & D) 7 May 2006.

Large, hardwood shrubs or trees to 8 (10) m tall, the trunks seldom straight. Twigs and leaves glandular-viscid: large, sessile glands on the leaves and internodes of young twigs eventually rupture, leaving glandular dot-like areas and coating the surfaces with viscid exudate, functioning as

extrafloral nectaries (Elias 1983; Henrickson 1985). These glands, however, do not break down at the nodes, where they likewise seem to function as extrafloral nectaries (Henrickson 1985). (Desert willow extrafloral nectaries seem to function largely at night, attracting mutualistic ants as well as ant-parasitoid wasps; Carrey et al. 2012). Leaves slender and often 6–20 cm long, drooping, and winter deciduous. Corollas 3–5 cm long, sweet scented, whitish to pale pink, streaked and mottled with purple and yellow nectar guide lines. Flowering April to August but especially in spring. Fruits of slender capsules 13–25 cm long and 0.5 cm wide, filled with flat, papery seeds with tufts of white hairs at each end.

Large washes in the northeastern part of Cabeza Prieta and the northern part of Organ Pipe, e.g., Kuakatch Wash to Growler Wash. In Kuakatch Wash it grows with blue palo verde, white-thorn acacia, desert hackberry, ironwood, and velvet mesquite in the sparse gallery of trees and shrubs lining the wash. In November 2001 the new growth on many of these desert willows was deformed with a "witches'-broom" apparently caused by mites.

This subspecies occurs in northern Sonora and Baja California to southeastern California, southwestern Utah, Arizona, and western New Mexico. Subspecies *linearis* occurs farther east in New Mexico, western Texas, and north-central Mexico southward to San Luis Potosí, and the southeasternmost population in Mexico is described as var. *tomenticaulis* (Henrickson 1985). This variety has dark rose-pink or purplish flowers, and is favored by the horticultural trade and widely planted in the Southwest including at Ajo; hybridization with native desert willow populations is a potential concern. "Fruitless" and lower-fruiting and other horticultural selections have been patented (e.g., Mountain States Nursery 2014). Desert willows can be clonally propagated by cuttings.

The flowers and slender fruits were eaten as a minor food by the Cahuillas (Bean & Saubel 1972). The tough, somewhat woody fruits, however, hardly seem edible. The Cahuillas and others used the strong and flexible wood and branches for bows, house construction, and other practical purposes including the bark or smaller branches for weaving material, nets, and in basketry (Bean & Saubel 1972; Moerman 1998).

OP: Along washes S of Walls Well, 31 Oct 1943, *Clark 11157* (ORPI). Growler Wash near Bates Well Road, 8 Oct 2006, *Rutman 2006-1008-13*.

CP: Daniels Arroyo at Charlie Bell Road, 12 Jun 1992, common along margin of wash, *Felger 92-547*. Growler Wash at Organ Pipe boundary, on both sides of the boundary, 12 Jun 1992, *Felger* (observation).

BORAGINACEAE – Borage Family

Annual (ephemeral) or perennial herbs (those in the flora area); many with rather harsh calcified or silicified (glassy) hairs, others with soft hairs, or glabrous. Leaves mostly alternate, the lower leaves sometimes opposite; first leaves of many species form a basal rosette; stipules none. Inflorescences mostly of circinate scorpioid cymes—coiled to one side distally, straightening as it grows, the flowers on one side; or flowers in small cymose clusters or axillary. Flowers radial (those in the flora area), 4- or 5-merous; calyces and corollas 4- or 5-lobed; stamens epipetalous; ovary 4-lobed in Boraginaceae sensu stricto, not lobed in Hydrophyllaceae. Many temperate and aridland borages (including those in the flora area) have dry fruits that split into 4 or fewer 1-seeded nutlets; those with fewer than 4 nutlets arrive at that condition by abortion of the developing fruit segments or parts. Others have multiple-seeded capsules. (Some borages in other regions have fleshy fruits.) Some borages are quite distinctive, while among others reliable identification often requires looking at small but unique nutlets. All borages, sensu stricto, should be considered poisonous due to the widespread occurrence of hepatotoxic pyrrolizidine alkaloids. Nearly worldwide, ±120 genera, ±2300 species.

We follow APG III (Angiosperm Phylogeny Group 2009), wherein Boraginaceae includes Hydrophyllaceae. Subsequent findings (e.g., Gottschling et al. 2014, Weigand et al. 2013; also see Stevens 2001) would place the genera in southwestern Arizona as follows:

Boraginaceae: *Amsinckia, Cryptantha, Eremocarya, Harpagonella, Johnstonella, Lappula, Pectocarya, Plagiobothrys*
Ehretiaceae: *Tiquilia*
Heliotropiaceae: *Heliotropium*
Hydrophyllaceae: *Eucrypta, Phacelia, Pholistoma*
Unplaced (sister to Cordiaceae, Ehretiaceae + Lennoaceae, and Heliotropiaceae): *Nama*

Boraginaceae in the flora area includes 14 genera with 34 modern species, 10 of which are also represented by fossils, and one fossil (*Cryptantha utahensis*) no longer occurs in the flora area (Table 1). Cool-season ephemerals make up 82% (28 species) of the modern flora, and the two facultative annual/perennials also are cool-season plants. There are no summer-growing ephemerals. The four perennials are herbaceous, and only *Heliotropium* (Ehretiaceae) and *Tiquilia* (Ehretiaceae) are non-seasonal in growth response. Thus, the Boraginaceae (sensu stricto), Hydrophyllaceae (sensu stricto), and *Nama* grow only during the cooler months.

Measurements of corolla width in the keys and descriptions represent the total diameter or width of the corolla limb on both sides of the corolla aperture or throat as well as the aperture itself.

1. Plants glabrous, succulent, and often halophytic ..... **Heliotropium**
1. Plants variously hairy, not succulent and glabrous.

2. Perennials, low-growing and usually long-lived, growing and flowering at various seasons; flowers axillary, single or clustered, essentially sessile; corollas lavender; stigmas 2 and capitate. ..... **Tiquilia**
2. Winter-spring ephemerals; flowers in scorpioid cymes or axillary; corollas lavender or not; or if herbaceous perennials, then the plants not low-growing.

3. Stems square in cross section, weak and scrambling, with hooked hairs on stem angles; calyx with conspicuous auricles (sepal-like appendages between calyx lobes) ..... **Pholistoma**
3. Stems not square, not weak and scrambling, hairs not hooked; calyx without auricles.

4. Plants stinky and markedly glandular-viscid; inflorescence branches tightly coiled to one side distally; fruits of capsules, seeds 4 to many ..... **Phacelia**
4. Herbage not stinky, not markedly viscid (except *Eucrypta*); inflorescences coiled or not; fruits of capsules or 1 to 4 nutlets.

5. Plants with stiff, glassy or conspicuously harsh hairs; corollas white or yellow-orange.

6. Corollas yellow-orange ..... **Amsinckia**
6. Corollas white.

7. Nutlets 2–4 per fruit, without a prominent ventral groove, the attachment scar narrowly triangular to linear or ± round, along an elongated ventral keel or at base of a short ventral keel ..... **Plagiobothrys**
7. Nutlets 1 or 4 per fruit, with an open to closed ventral groove, usually forked or widened near the base, the attachment scar variable in shape, generally recessed, sometimes minute; ventral keel absent
..... **Cryptantha** sensu lato (includes **Eremocarya** and **Johnstonella**)

5. Herbage softer, hairs not harsh; corollas white, bluish, pinkish or lavender.

8. Corollas white or bluish; fruits usually of 4 nutlets (2 in *Harpagonella*), seeds 1 per nutlet.

9. Plants staining reddish when pressed; calyx circumscissile, the calyx and nutlets without spine-like appendages or teeth, the attachment scar located at the base of a central keel ..... **Plagiobothrys arizonicus**
9. Plants not staining reddish; calyx not circumscissile, the calyx and/or some nutlets bearing spine-like appendages or teeth (*Harpagonella* has unornamented nutlets but a spinescent calyx).

10. Calyx bur-like; one pair of calyx lobes fused, accrescent, enclosing 1 or both nutlets, with spine-like appendages on the back; nutlets 2, not toothed (caution: in this couplet, do not confuse calyx lobes with the nutlets) ..... **Harpagonella**
10. Calyx not bur-like; calyx not accrescent and not enclosing nutlets, without spine-like appendages; nutlets usually 4, the margins often toothed.

11. Plants generally erect, the main axis well developed; corollas pale blue or whitish; nutlets held upright, the marginal teeth (spines) barbed ..... **Lappula**
11. Plants often spreading and without a strong main axis; corollas white; nutlets spread open like tiny, open jaws, the marginal teeth not barbed (hooked at tip in *P. anisocarpa)* ..... **Pectocarya**

8. Corollas pinkish, purplish, or white; fruits of capsules with more than 4 seeds.

12. Leaves sessile or the blade tapering into the petiole, the margins entire (sometimes inrolled); corollas pinkish or purplish ..... **Nama**
12. At least the lower leaves petioled, the petiole and blade clearly differentiated, the blades pinnately lobed, or toothed or wavy; corollas whitish, pale violet, or lavender, with a pale yellow throat.

13. Stems slender and delicate, not succulent; leaf blades pinnately lobed; corollas pale violet, or lavender, with a pale yellow throat ..... **Eucrypta**
13. Stems thick, semi-succulent, short and stubby; leaf blades ovate; corollas whitish ..... **Phacelia neglecta**

Amsinckia – Fiddleneck

Winter-spring ephemerals, mostly erect, the herbage with coarse, often bulbous-based hairs. Flowers in scorpioid cymes, coiled to one side distally, the corollas bright yellow-orange (no other Sonoran Desert borages have yellow or orange corollas). Nutlets 4, homomorphic. The two species in the flora area are common and widespread, often growing intermixed along washes, canyons, floodplains, valley bottoms, bajadas, and rocky slopes. There is great variation in ornamentation and sculpturing of the nutlets, which led Wilhelm Suksdorf (1931) to recognize about 235 species of *Amsinckia*, nearly all of them subsequently buried in synonymy.

The genus includes about 14 species; western North America and two species in southwestern South America.

1. Calyx lobes 5, about equal in size; back of nutlets rough with ragged-edged ornamentations, arched with a high dorsal spine-ridge..... **Amsinckia intermedia**
1. Calyx lobes 3 to 5, unequal in size, often 2- or 3-toothed at tip due to fusion of lobes; back of the nutlets enamel-like with smooth-edged bumps (tessellated), not conspicuously arched, the dorsal ridge not raised or only slightly so..... **Amsinckia tessellata**

Amsinckia intermedia Fischer & C.A. Meyer
Devil's lettuce, common fiddleneck; cetkom. Figures 5 & 6.

Plants often 30–50 cm tall, and sometimes to 1 m tall in favorable, seasonally wet places. Calyx lobes all alike. Corolla tube about 10-veined below insertion of the stamens. Nutlets 2.4–2.6 mm long, relatively deep and arched, the dorsal side (back) with a high ridge-crest, sculptured with sharp, ragged surfaces. Plants, inflorescence branches, and hairs often less robust than those of *A. tessellata*; also the inflorescences tend to become more elongated and slender in *A. intermedia*.

Widespread across the flora area in many habitats including valley floors, hills and mountains. This species has been in the Tinajas Altas Region for at least 11,300 years. Widespread in western North America.

There are reports of young plants eaten as greens, cooked or even fresh (Hrdlička 1908 and Russell 1908, as interpreted by Rea 1997). Felger (2007) agreed with Amadeo Rea that these unpleasant, rough-haired plants hardly seem palatable. Suksdorf "recognized over 100 species that fall within" *A. intermedia* (Higgins 1979: 312).

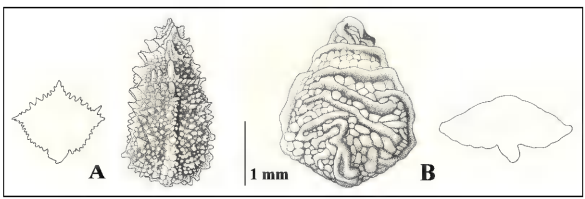

Figure 5. *Amsinckia* nutlets. Cross-sections and dorsal views; from Gran Desierto, NW Sonora, by Matthew B. Johnson: (A) *A. intermedia*; (B) *A. tessellata* var. *tessellata*.

OP: Aguajita Wash, 6 Apr 1988, *Felger 88-305*. 0.6 mi E of Lukeville, 20 Feb 1988, *Felger 88-03*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-279* (ORPI).

CP: Charlie Bell Road just W of ORPI boundary, 25 Jan 1993, *Felger 93-58*.

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Camino del Diablo, S end of Coyote Wash, 28 Mar 2010, *Felger 10-169*. †Butler Mts, nutlet, 11,250 ybp. †Tinajas Altas, nutlet, 9230 ybp.

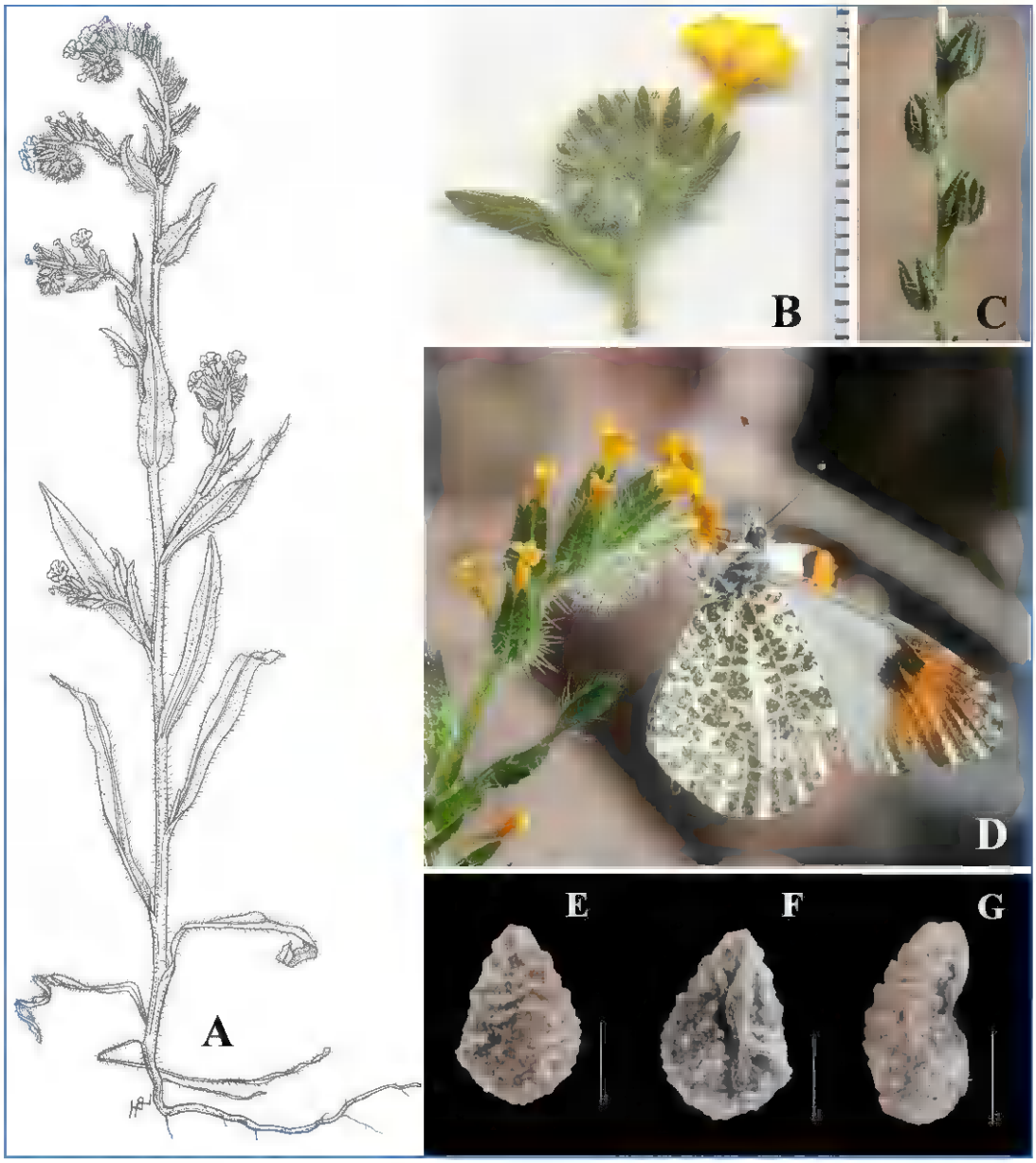

Figure 6. *Amsinckia intermedia*. (A) By Lucretia Breazeale Hamilton. Alamo Canyon: (B) 28 Feb 2009; (D) with southwestern orangetip (*Anthrocharis sarathoosa*), 4 Mar 2009. (C) Kuakatch Wash near Hwy 85, 3 Mar 2014. (E–G) Nutlet, dorsal, ventral, and lateral view, bar = 1 mm; Claremont, CA, 26 Apr 1948, *Gallup 145* (SDSU 4890); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/amsinckia/taxa.html

Amsinckia tessellata A. Gray var. **tessellata**
Checker fiddleneck; cetkom. Figures 5 & 7.

Plants resembling *A. intermedia* but often larger and more robust. Calyx lobes usually unequal with 2 of the lobes united. Corolla tube with about 20 veins below the insertion of the stamens. Nutlets 2.8–3 mm long, the back tessellated with a mosaic of crowded, broad, irregular, and smooth-edged bumps like cobblestone wrinkled by an earthquake, and sometimes with smooth, transverse ridges.

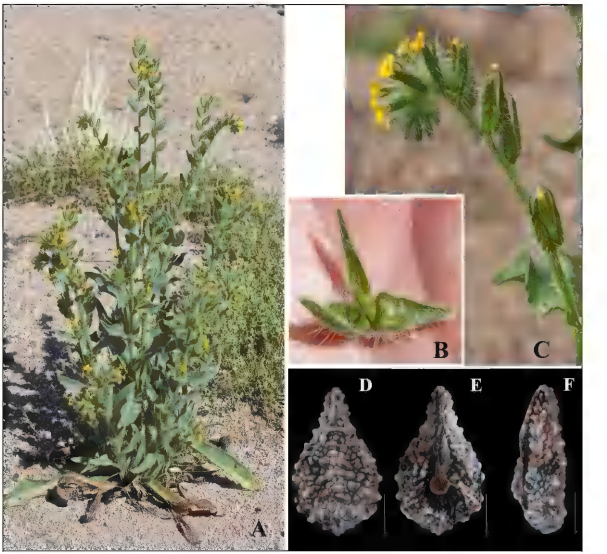

Figure 7. *Amsinckia tessellata* var. *tessellata*. (A) Kuakatch Wash near Hwy 85, 3 Mar 2014. Alamo Wash: (B) sepals and developing nutlets, 11 Mar 2014; (C) 4 Mar 2009. (D–F) Nutlet, dorsal, ventral, and lateral view, bar = 1 mm; Anza-Borrego State Park, San Diego Co., CA, 19 Mar 2005, *Gregory 1327* (SD 173640); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/amsinckia/taxa.html

Widespread in Cabeza Prieta and Organ Pipe, and Tinajas Altas at the west boundary of Cabeza Prieta. Rocky to gravelly, sandy, or cinder soils; slopes, pediments, flats, and arroyo beds. This species has been in the flora area for more than 21,000 years.

Eastern Washington, Idaho, and Utah to Baja California and northern Sonora. An additional variety occurs in California. This species is disjunct in South America.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Bates Well, 22 Apr 1942, *Cooper 727*. Aguajita Wash, *Beale 8 Apr 1988* (ORPI). †Alamo Canyon, nutlets, 21,110 ybp. †Montezuma's Head, nutlets, 17,830 & 20,490 ybp. †Puerto Blanco Mts, nutlets, 9860 ybp.

CP: Jose Juan Tank, 23 Feb 1993, *Felger 93-104*. Buckhorn Tank, 27 Feb 1993, *Felger 93-181*. Camino del Diablo at W boundary of Refuge, 27 Feb 1993, *Felger 93-197*.

TA: Camino del Diablo at E boundary of Tinajas Altas Region, 28 Mar 2010, *Felger 10-161*. †Butler Mts, nutlets, 10,360 ybp. †Tinajas Altas, nutlets, 9230 to 15,050 ybp (3 samples).

Cryptantha sensu lato

Winter-spring ephemerals plus two perennial species (*Johnstonella holoptera* and *J. racemosa*) growing and flowering only during the cooler seasons; with glassy or coarse hairs. Leaves slender and sessile. Flowers in scorpioid cymes, coiled to one side distally, or sometimes not evidently coiled or only slightly so. Flowers small and white (those in the flora area). Fruits with 1–4 nutlets enclosed in a calyx covered with harsh, glassy or coarse hairs. Nutlets often dissimilar (heteromorphic) in size and ornamentation, and how readily they fall out of the calyx, or all similar (homomorphic) (Figure 8). The different nutlets morphologies including sizes (weights) can lead to different strategies for dispersal and establishment (e.g., Felger 2000). In the classical sense, *Cryptantha* sensu lato includes 150 species in North America, especially the western part, and in Andean South America.

Hasenstab-Lehman and Simpson (2012) show that *Cryptantha* in the broad sense is not monophyletic, and those in the Sonoran Desert are best classified into three genera: *Cryptantha*, *Eremocarya*, and *Johnstonella*.

Key to the species of *Cryptantha* sensu lato

1. Nutlet margins sharp-edged, knife-like, or winged.

2. Nutlet margins knife-edged but not winged; inner face of nutlet flat; back of nutlet smooth and markedly convex. ..... **Johnstonella costata**
2. Nutlet margins winged (very narrowly so in *J. racemosa*); inner nutlet face not flat; back of nutlet studded with bumps.

3. Ephemerals; calyx broad (lobes ovate to lance-ovate); wing of nutlet usually as wide as body and fringed with finger-like projections. ..... **Cryptantha pterocarya**
3. Ephemerals to perennials; calyx narrow (lobes lanceolate); wing of nutlet narrower than the body and entire.

4. Bark not peeling away or only moderately exfoliating with age; nutlets similar in size, the margin with a ribbon-like wing. ..... **Johnstonella holoptera**
4. Bark conspicuously peeling away; nutlets dissimilar in size, the margin with a very narrow bead-like wing. ..... **Johnstonella racemosa**

1. Nutlet margins rounded or angled but not knife-edged or winged.

5. Inflorescences strongly coiled to one side distally; flowers without bracts between (subtending) them.

6. Plants often about as wide as tall, branching from near base; flowers crowded in inflorescence; nutlets within a fruit dissimilar (heteromorphic), 4 per fruit, nutlet toward inflorescence axis larger than the other 3. ..... **Johnstonella angustifolia**
6. Plants often taller than wide; flowers often not crowded in inflorescence; nutlets 1 or if 3 or 4 then all of the same size and similar within a fruit (homomorphic).

7. Nutlets rough (tuberculate), (1) 4 per fruit..... **Cryptantha barbigera**
7. Nutlets smooth, 1 (occasionally 2) per fruit. ..... **Cryptantha ganderi**

5. Inflorescences not prominently coiled to one side distally; bracts beneath (subtending) at least some flowers.

8. Stems not unusually slender, not wire-like; dye in roots and stems not conspicuous; bracts few; nutlets 1..... **Cryptantha maritima**
8. Stems markedly slender, wire-like; roots and stems with copious purple dye; each flower subtended by a leaf-like bract; nutlets 4..... **Eremocarya micrantha**

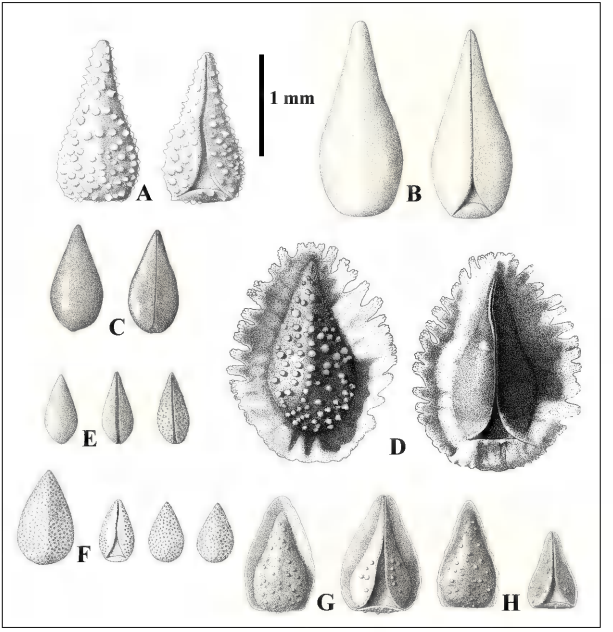

Figure 8. Nutlets of *Cryptantha*, *Eremocarya*, and *Johnstonella*. (A) *Cryptantha barbigera* var. *barbigera*; (B) *C. ganderi*; (C) *C. maritima*; (D) *C. pterocarya* var. *cycloptera*; (E) *Eremocarya micrantha*; (F) *Johnstonella angustifolia*; (G) *J. holoptera*; (H) *J. racemosa*; by Matthew B. Johnson (from Felger 2000).

Cryptantha

Annuals in North America (cool-season ephemerals in the Sonoran Desert), mostly the western part, 55 species; and 68 species in Andean South America, including two also in North America (amphitropical species) (www.sci.sdsu.edu/plants/cryptantha/).

Cryptantha barbigera (A. Gray) Greene var. **barbigera**
Bearded cryptantha, bearded cat's eye. Figures 8A & 9.

Plants often 15–55 cm tall, the inflorescences open and loose with several long branches, or the plants sometimes only 3–6+ cm tall when water stressed. Larger leaves often 3–17 × 0.4–1.4 cm, linear to lanceolate, the apex obtuse; often not forming a basal rosette. Inflorescences prominently coiled distally. Calyx, especially basally, with long, white hairs (hence the specific and common names). Corollas often 4 mm wide. Nutlets (1.7) 1.8–2.2 mm long, (1–3) 4 per fruit, homomorphic, the surfaces brown to gray with prominently raised bumps (tuberculations) throughout, the margins rounded, the inner face not flat, the ventral groove and nutlet itself slightly crooked. The plants sometimes sterile with abnormal growth apparently caused by infestations of mites.

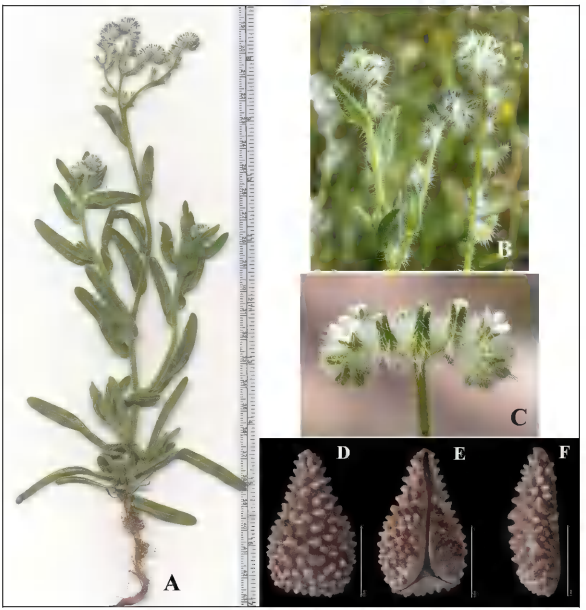

Figure 9. *Cryptantha barbigera* var. *barbigera*. (A) Alamo Wash near Hwy 85, 5 Mar 2014. (B) Chico Shunie area, 26 Feb 2005. (C) Victoria Mine, Puerto Blanco Mts, 1 Apr 2010. (D–F) Nutlet, dorsal, ventral, and lateral views, bar = 1 mm; Anza-Borrego State Park, San Diego Co., CA, 6 Jun 1991, *Simpson 6V19AD* (SDSU 5378); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_barbigera/v_b/

Widespread across the flora area in many habitats; sandy soils of washes and plains, and on rocky slopes to higher elevations. It has been in the flora area for at least 13,500 years.

Variety *barbigera* ranges from southeastern California to southwestern Utah, Arizona, southern New Mexico, west Texas, Baja California, and northern Sonora. *Cryptantha barbigera* var. *barbigera* from Arizona and farther east has a distinctive appearance, being more slender with slightly larger corollas than Californian populations, however the bearded calyx is a constant feature (Ronald B. Kelley, pers. comm. to R. Felger, 2014). Another variety, *C. barbigera* var. *fergusoniae* J.F. Macbride, occurs in the California deserts.

OP: Puerto Blanco Mts, *Nichol 25 Feb 1939*. Alamo Canyon, 12 Apr 1978, *Bowers 1249*. 2 mi E of Bates Well, 30 Mar 1979, *Bowers 1595*. Aguajita, 23 Oct 1987, *Felger 87-260*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-288*. †Montezuma's Head, nutlets, 13,500 ybp. †Puerto Blanco Mts, nutlets, 9070 ybp.

CP: Tule Mts, 23 Mar 1935, *Kearney 10880*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3943* (CAB). Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-273*.

TA: Tinajas Altas Mts, above the tinajas, 19 Mar 1998, *Felger 98-137*. †Tinajas Altas, nutlets, 5080 ybp.

Cryptantha ganderi I.M. Johnston
Dune cryptantha. Figures 8B & 10.

Plants often 10–30 cm tall, vegetatively similar to *C. barbigera* but usually with somewhat smaller, narrower leaves and more rigid stems. Larger leaves 4.5–8 cm × 2.2–5 mm, not in a basal rosette. Inflorescences prominently coiled distally. Corollas pure white, 2.8–3.5 mm wide. Nutlets 2.6–2.9 mm long, smooth, 1 (2) per fruit (ovules or immature nutlets rarely 3).

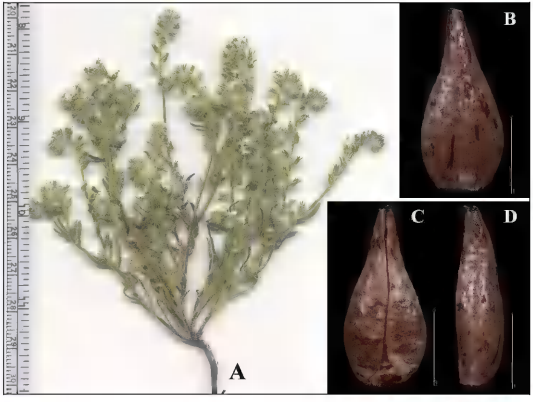

Figure 10. *Cryptantha ganderi*. (A) Dunes, Mex Hwy 2 through Gran Desierto, W of Tule Mts, Sonora, 5 Mar 2014. (B–D) Nutlet, dorsal, ventral, and lateral views, bar = 1 mm; San Diego Co., CA, 19 Mar 1983, *Armstrong 252* (SD 115050); by Michael G. Simpson, and students, <http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_ganderi/>

Locally the most common cryptantha on dunes and sand flats of the Pinta Sands, often growing with *Eremocarya micrantha* and *Johnstonella angustifolia*. Common in sand soils of northwestern Sonora, and in Arizona known only from the Pinta Sands and Mohawk Dunes. Also localized in sand soils in NE Baja California and in SE California. It was not confirmed for Arizona until 1993 (Felger et al. 1993).

Cryptantha ganderi is a dune and sand endemic perhaps related to *C. barbigera*. Hasenstab-Lehman and Simpson (2012) show that it is closely related to *C. intermedia*, which shows similarities to *C. barbigera*. The vegetative plants might be confused with those of *C. barbigera*; *C. ganderi* nutlets are similar in shape to those of *C. barbigera* but larger, smooth and slightly more slender, the ventral groove narrower and straight (rather than crooked), and the sinus at the base of the groove smaller. Also *C. ganderi* usually has only 1 nutlet whereas *C. barbigera* has 1 to 4.

CP: Dunes S of E side of Pinacate lava flow–Camino del Diablo junction, 21 Mar 1992, *Harlan 90* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-388*.

Cryptantha maritima (Greene) Greene var. **maritima**
[*C. maritima* var. *pilosa* I.M. Johnston]
White-haired cryptantha. Figures 8C & 11.

Plants highly variable in size, often with an erect main axis and branching mostly above the middle. Stems dark brown to red-brown, foliage often dark green, the dead, dark brown leaves persisting on stems. Inflorescence branches short, reaching 2 (3.5) cm, scorpioid cymes only slightly coiled at the tips, appearing racemose. Corollas 0.5–1.5 mm wide. Fruiting calyx slender, with relatively large glassy hairs, and much longer than the enclosed nutlet. Nutlets 1.2–1.5 mm long, smooth, shiny, dark red-brown, slender, 1 per fruit. As with *C. barbigera*, the plants are sometimes deformed, apparently due to mite infestations.

Common throughout the flora area in many habitats; washes and sand flats to rocky slopes often to their peaks. This species has been in the flora area for more than 11,000 years.

Western and southern Arizona, southern Nevada, southern California, both Baja California states, and Sonora south to the Guaymas region, and disjunct in South America.

Variety *pilosa* does not seem worthy of recognition; it often occurs freely intermixed and intergrades with var. *maritima* (Felger 2000; Simpson & Hasenstab 2009). Variety *maritima* has 2 ovules and 1 or 2 nutlets, although all specimens seen in the flora area and adjacent northwestern Sonora have 1 nutlet; plants in California often have 2 nutlets, one smooth and one tuberculate. The distinctive *C. maritima* var. *cedrosensis* (Greene) I.M Johnston on Isla Cedros off the coast of Baja California has 4 ovules and 1–4 nutlets.

OP: Quitobaquito, 18 Mar 1945, *Gould 3005*. Sierra de Santa Rosa, 11 Feb 1978, *Bowers 1032*. SE of Dripping Springs, 29 Jan 1986, *Phillips 86-6* (ORPI). Aguajita Wash, *6 Apr 1988, Felger 88-269*. †Puerto Blanco Mts, calyces, nutlets, 9070 & 9720 ybp. †Montezuma's Head: fruits with calyces and nutlets (1 per fruit, smooth, 1.8 mm long), 20,490 ybp; fruits with calyces, nutlets (1 per fruit, smooth), 21,840 ybp.

CP: Tule Tank, *Goodding 6 Mar 1940* (ASU). 8 mi E of Papago Well, Agua Dulce Mts, 14 Apr 1941, *Benson 10758*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3916* (CAB). Cabeza Prieta Peak, summit, 24 Mar 1995, *Yeatts 3660* (CAB).

TA: Tinajas Altas, 23 Mar 1935, *Kearney 10905*. †Butler Mts, calyx, nutlets, 740 to 10,360 ybp (3 samples). †Tinajas Altas, fruits, nutlets, 4010 to 11,040 ybp (8 samples).

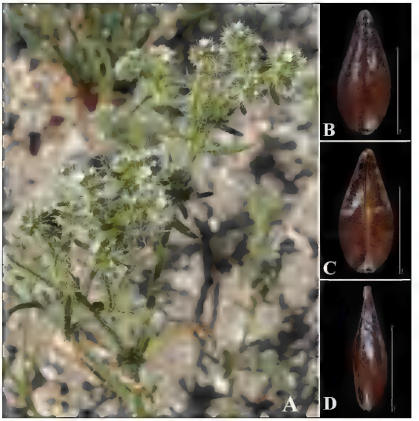

Figure 11. *Cryptantha maritima* var. *maritima*. (A) Desert Hot Springs, Riverside Co., CA, photo by Max Licher (SEINet). (B–D) Nutlet, dorsal, ventral, and lateral views, bar = 1 mm; E shore of San Ignacio Lagoon, Baja California Sur, 26 Mar 1974, *Moran 21176* (SD 86945), by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_maritima/C_maritima_v_m/

Cryptantha pterocarya (Torrey) Greene var. **cycloptera** (Greene) J.F. Macbride
Wing-nut cryptantha, fringe-nut cryptantha. Figures 8D & 12.

Plants erect and unbranched, or with mostly few, ascending branches. Inflorescences appearing racemose, only slightly coiled distally on larger plants. Calyx appearing angled due to thickened midribs of calyx lobes, these broadly ovate, obtuse, and bright green, becoming tan, and enlarging to 4.5–6 mm long as the fruit matures. Corollas 1–1.5 mm wide. Nutlets homomorphic, 2.5–3 mm long, 4 per fruit, intricately sculptured, the body studded with blunt tubercles and edged by a broad, light-colored wing edged with blunt, finger-like projections, the wings often bent as they grow crammed in the calyx, the wings and body the color of milk chocolate speckled with darker blotches. (In occasional water-stressed plants the wing-margin of the odd nutlet is much narrowed but not wingless.) This *Cryptantha* is readily recognized by the relatively large fruits and broad sepals, green when fresh and only moderately hairy, and relatively large nutlets with broad, ornamented wings.

Common throughout the flora area in many habitats including desert flats, washes, canyons, bajadas, and rocky slopes often to their summits. Its history in the flora extends to at least 22,000 years.

Variety *cycloptera* is widespread in Sonora, both Baja California states to Washington and Utah, and eastward to New Mexico and western Texas. Two other varieties in western United States and northwestern Mexico.

Figure 12. *Cryptantha pterocarya* var. *cycloptera*. Alamo Wash: (A) 5 Mar 2014; (B) 11 Mar 2014. (C) Sierra Los Tanques near Mex Hwy 8, Sonora, 19 Mar 2010. (D) Dorsal and ventral view of nutlet, bar = 1 mm: Hills near Tucson, *Pringle 15 Apr 1884* (SD28896), by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_pterocarya/var_cycloptera/C_pterocarya_v_cycloptera.html

OP: Alamo Canyon, 23 Mar 1941, *McDougall 19*. Victoria Pass, 8 Apr 1941, *McDougall 54*. 2 mi WSW of Bates Well, 30 Mar 1978, *Bowers 1124*. Twin Peak, 4 Mar 1984, *Van Devender 84-49*. Quitobaquito, 29 Mar 1988, *Felger 88-122*. †Alamo Canyon, nutlets, 8590 & 9570 ybp. †Montezuma's Head: Nutlets, 13,500 ybp; Fruits with calyces and nutlets (nutlets 3, the body 1.6 mm long, gray with tubercles, and very narrow band-like margin, not really winged but the margin is somewhat irregular and not smooth-edged, it appears to be *C. pterocarya* that has not formed a broad wing; the body color and size, shape, and tubercles match in every way except the narrow margin—although the nutlet margins can sometimes be narrow or absent in modern specimens), 20,490 ybp; Fruits with calyces, nutlets 4, nearly all alike, about same size, dull gray with whitish tubercles, and narrow slightly scalloped margins, the wings appear not fully formed, 21,840 ybp. †Puerto Blanco Mts, nutlets, 2340 & 9070 ybp.

CP: Tule Tank, 23 Mar 1935, *Kearney 10893.* Charlie Bell Pass, 3 Apr 1992, *Whipple 5918.* Bassarisc Tank, 26 Feb 1993, *Felger 93-123.* Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-274* (CAB). Cabeza Prieta Peak, summit, 24 Mar 1995, *Yeatts 3660.1* (CAB).

TA: Tinajas Altas, 1700 to 1900 ft, on cliffs, *Van Devender 10 Mar 1980.* †Butler Mts, nutlets, 10,360 ybp. †Tinajas Altas, nutlets, 11,040 ybp.

††**Cryptantha utahensis** (A. Gray) Greene

Ephemerals, presently in the Mojave Desert and pinyon-juniper regions of Mohave County, Arizona, above about 950 m, and east-central California to southwestern Utah.

TA: †Tinajas Altas, calyx, nutlets, 11,040 ybp.

Eremocarya

Eremocarya has two species. *Eremocarya lepida* (A. Gray) Greene (*E. micrantha* var. *lepida* (A. Gray) J.F. Macbride) occurs in southwestern California and northwestern Baja California (Simpson et al. 2014).

Eremocarya micrantha (Torrey) Greene

[*Cryptantha micrantha* (Torrey) I.M. Johnston. *Eritrichium micranthum* Torrey]

Dwarf cryptantha. Figures 8E & 13.

Diminutive ephemerals with very slender stems, the roots and stems staining bright red-purple when pressed. This is the smallest cryptantha sensu lato in the region. Plants 3–10 cm tall, branched mostly above, stems very slender, the bark peeling on the lower stems of larger, older plants; hairs small, mostly appressed. Leaves 3–8 mm long, relatively few and scattered, those of the first 1 or 2 nodes opposite and not in a basal rosette. Inflorescence branches not strongly coiled, reaching 5 (15) mm long. Flowers minute, each subtended by a leafy bract; corollas 0.8–1.5 mm wide, white with a yellow center. Nutlets homomorphic or heteromorphic, 4 per fruit, 0.9 mm long, slender, either all smooth or all rough (tuberculate), or with 1 rough and 3 smooth nutlets.

Sandy soils and dunes in the Pinta Sands area of Cabeza Prieta.

Oregon and California to Utah, Baja California, Arizona, and northwestern Sonora, and eastward to western Texas.

CP: Pinacate Lava Fields, 20 Mar 1933, *Shreve 6217.* W side of Pinacate lava, 29 Mar 1985, *McLaughlin 2990.* Pinta Sands, 1 Feb 1992, *Felger 92-17.*

Eucrypta

Delicate plants, aromatic and viscid-glandular. Leaves pinnatifid, opposite below, alternate and reduced above; petiole bases clasping the stem. Flowers axillary or more often on few-flowered slender branches, the pedicels thread-like, elongating in fruit. Calyx divided about ½ to ¾ of the way to the base, the lobes enlarging slightly in fruit. Stamens not protruding from corolla. Style bifid near apex. Seeds several to 16. The plants frequently grow under trees and shrubs and at the base of rocks. This genus includes two species.

1. Leaf lobes shallowly pinnatifid, the tips obtuse-angled rather than rounded; calyx glands not stalked; calyx opening wide (like a dish) at maturity to expose the capsule, the calyx lobes broadly spreading; seeds dimorphic. ..... **Eucrypta chrysanthemifolia**

1. Leaf lobes entire or sometimes few-toothed, the tips rounded; calyx with sessile and usually also stalked glands; calyx lobes erect and enclosing the capsule (only tip of capsule visible); seeds all alike. ..... **Eucrypta micrantha**

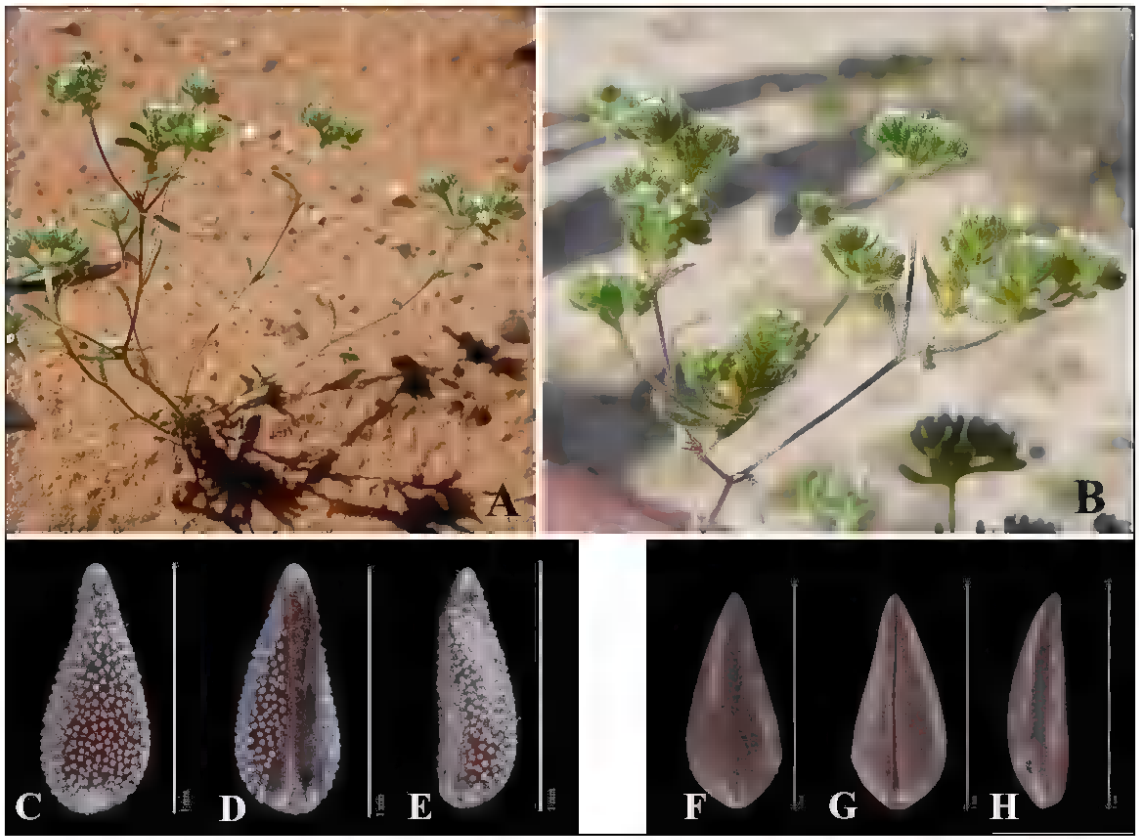

Figure 13. *Eremocarya micrantha*. (A) Red Rock State Park, near Sedona, Yavapai Co., 22 Apr 2001, photo by Max Licher (SEINet). (B) Mohawk Dunes, 3 Mar 2014, photo by Sue Carnahan (SEINet). Nutlets, dorsal, ventral, and lateral views, bar = 1 mm: (C–E) tuberculate (rough) nutlets, Pinyon Wash, Anza-Borrego State Park, San Diego Co., CA, 12 Apr 1963, *Morgan K83* (SDSU 05421); (F–H) smooth nutlets, Borrego Valley, San Diego Co., CA, 25 Mar 1933, *Purer 4943* (SD 39196); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/eremocarya/taxa/E_micrantha/

Eucrypta chrysanthemifolia (Bentham) Greene var. **bipinnatifida** (Torrey) Constance
Spotted hideseed. Figure 14.

Plants highly variable in size depending on soil moisture and shading. Stems 4–15 (25) cm long. Leaves pinnatifid to partially bipinnatifid, mostly 1.5–7 × 0.5–3 (4) cm, "fern-like" or finely dissected. Calyx divided about ⅔ of the way to the base, at maturity (4.5) 5.5–6.5 mm across, rotate, the lobes spreading to reveal the capsule; calyx pubescent but without stalked glandular hairs. Corollas pale lavender. Capsules at maturity separating into 2 conic-hemispherical halves with stout white hairs. Seeds dimorphic within the same capsule: several seeds chunky, blunt-ended, and irregularly lumpy-wrinkled, dark brown with age, 1 mm long, and 2 seeds light brown, 1.2 mm long, flattened and concave on one side, and sharp-edged and strongly convex (almost conic) on the other side, essentially smooth on both sides (the convex side minutely reticulate).

Widespread and often common in canyons and on rocky slopes, especially north-facing, and in washes, and less common on flats and in open areas. High elevations in Ajo Mountains to low elevations across Organ Pipe and much of Cabeza Prieta, especially the eastern two-thirds. *Eucrypta chrysanthemifolia* and *E. micrantha* often grow intermixed; *E. chrysanthemifolia* seems to favor slightly more mesic microhabitats and be the more common of the two at higher elevations.

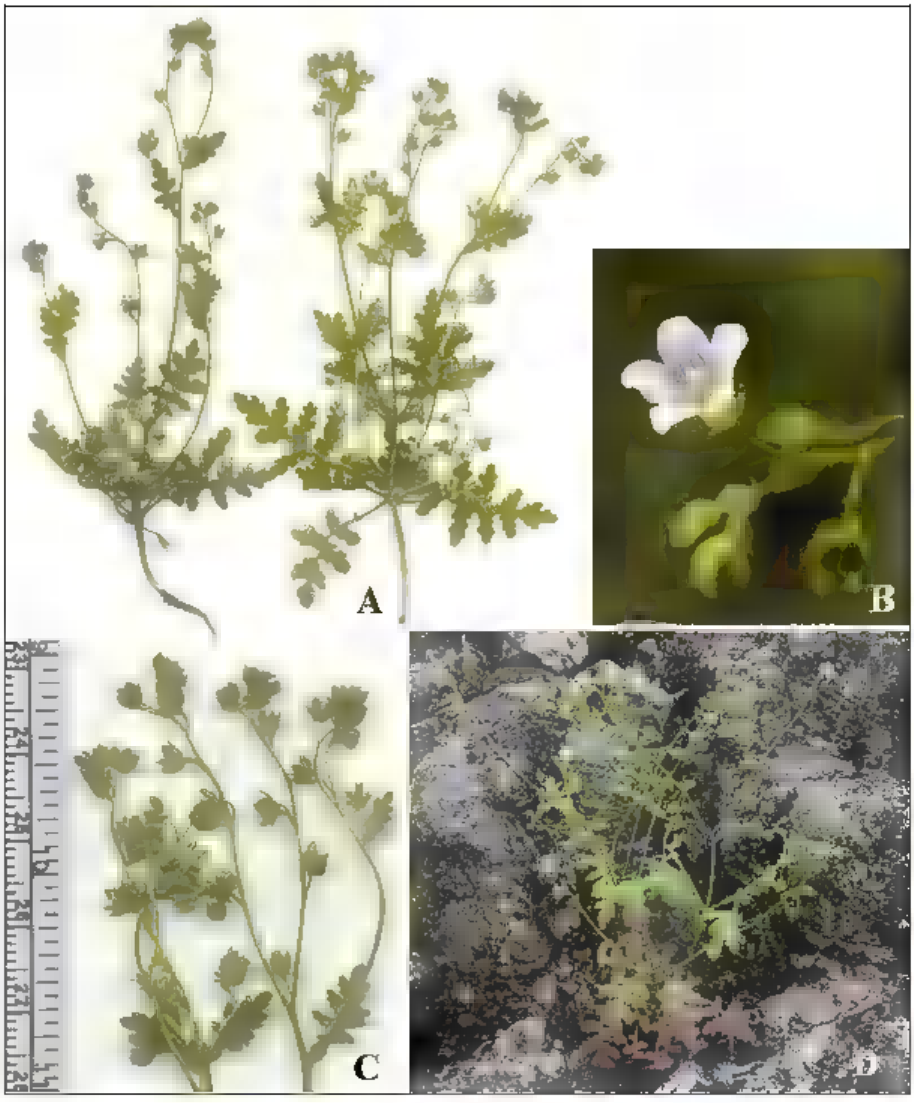

Figure 14. *Eucrypta chrysanthemifolia* var. *bipinnatifida*. (A) Estes Wash, 28 Feb 2009. (B) Jesusita Trail, N of Santa Barbara, Santa Barbara Co., CA, 11 Apr 2009, photo by Patrick Alexander (SEINet). (C) Alamo Canyon near Alamo Well, 11 Mar 2014. (D) Estes Canyon, 5 Mar 2005.

Variety *bipinnatifida* in deserts in Arizona, southern Californica, Nevada, Baja California, and to southern Sonora in thornscrub. Replaced by var. *chrysanthemifolia* on the Pacific coast of California and Baja California.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10827*. Alamo Canyon, 14 Mar 1941, *Benson 10661*. Victoria Pass near Burnham's Mine, 8 Apr 1941, *McDougall 52*. Quitobaquito, 29 Mar 1988, *Felger 88-134*. Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-268*.

CP: Camino del Diablo, 7.6 mi E of Papago Well, 12 Mar 1983, *Daniel 2656* (ASU). Heart Tank, 27 Feb 1993, *Felger 93-158* (CAB).

Eucrypta micrantha (Torrey) A. Heller
Desert hideseed; *peluda*. Figure 15.

Plants with stalked glandular hairs intermixed with non-glandular hairs. Stems often 5–23 (28) cm long, erect to ascending, sometimes spreading on larger plants or when shaded. Leaves pinnatifid, 1.5–5 × 0.5–2.6 cm. Calyx usually divided about halfway or more to the base, beset with stalked glandular hairs as well as non-glandular hairs; fruiting calyx 3–6 mm long, not spreading open at maturity (revealing only the tip of the capsule). Corolla lobes white, pale violet, or lavender, the throat yellow with yellow nectaries and often nectar-filled in the morning. Capsules splitting but the 2 carpels not falling free, the halves obovoid, with obtuse tips. Seeds up to 16 per capsule, all alike, brownish black, 0.8–1 mm long, incurved and cylindrical, with sharply sculptured transverse ridges.

Figure 15. *Eucrypta micrantha*. Kuakatch Wash near Hwy 85: (A) 28 Jan 2013; (C) 13 Mar 2010. (B) Alamo Canyon near the well, 1 Feb 2014. (D) Estes Wash, 21 Mar 2010.

Widespread and common from the Ajo Mountains to low elevations across the flora area.

Southeastern California to Nevada, Utah, and Texas, Baja California, and northern Sonora.

OP: Valley back of Montezuma Head, 28 Mar 1941, *McDougall 43.* Quitobaquito, *Nabhan 18 Feb 1983.* Armenta Road 1.4 mi W of Ariz Hwy 85, 11 Mar 2003, *Felger 03-269.*

CP: Eagle Tank (Simmons 1966). Charlie Bell Pass, 3 Apr 1992, *Whipple 3921.* 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002.* Chico Shuni Well, 2 Feb 2003, *Rutman 2003-40.*

TA: Tinajas Altas, *Van Devender 5 Mar 1983.* Canyon below Raven Butte Tank, 29 Mar 2010, *Felger 10-229.* Coyote Water, 21 Feb 2005, *Felger 05-134.*

Harpagonella

This genus has two taxa.

Harpagonella palmeri (A. Gray) var. **arizonica** I.M. Johnston
Arizona grappling-hook. Figure 16.

Small spring ephemerals resembling a *Pectocarya*. Inflorescences of scorpioid cymes, coiled to one side distally in young plants but appearing racemose in older plants. Flowers small and white. Pedicels ascending, recurved to coiled in fruit. Upper 2 calyx lobes partly fused, the lower 3 calyx lobes smaller and separate from each other. Fruits tightly enclosed in a highly modified and strongly accrescent bur-like calyx becoming indurate with spinescent sepal lobes 3–4.5 mm long with hooked spines and enveloping the nutlets. Nutlets 2, spreading, and heteromorphic, the margins entire.

Common in open, rocky areas in Bull Pasture in the Ajo Mountains and otherwise known in the flora area from the Santa Rosa Mountains.

Variety *arizonica* occurs in southwestern Arizona and northern Sonora, but not in the drier, lower-elevation regions. In a forthcoming publication, Matt Guilliams and Bruce Baldwin treat variety *arizonica* as a distinct species. Variety *palmeri* occurs in southwestern California and Baja California including Isla Guadalupe. The nutlets are similar in both taxa although those of var. *arizonica* are larger and the whole fruit and calyx appendages of var. *arizonica* are larger than those of var. *palmeri*.

OP: Near Diaz Peak, 1070 m, *Dakan 11 Feb 1973* (ORPI). Bull Pasture, 10 Apr 2005, *Felger 05-218.*

Heliotropium

A diverse, worldwide genus of about 250 species.

Heliotropium curassavicum Linnaeus var. **oculatum** (A.A. Heller) I.M. Johnston ex Tidestrom
Alkali heliotrope; *hierba del sapo*; babad 'i:vakĭ, kakaicu 'i:vakĭ. Figure 17.

Perennial herbs often with somewhat thickened rootstocks, and often flowering in the first season; glabrous, semi-succulent to succulent, and bluish glaucous. Above ground parts frost-sensitive. Leaves mostly 2.5–7.5 cm long. Inflorescences terminal, of 2–several spike-like scorpioid cymes, coiled to one side distally. Corollas 4–7 mm wide, white with a yellow center that changes to purple with age. Stigma sessile. Fruits of 4 ovoid nutlets. Growing and flowering with warm to hot weather any time of year.

At various waterholes, occasionally along washes or canyons with temporary water, and moist, alkaline soils at Aguajita, Quitobaquito, and Williams Springs. Mule deer at Dripping Spring in Organ Pipe are known to dig down to eat the roots during the pre-summer dry season.

California east across the Southwest to Texas and northern Mexico; often in alkaline or saline soils. The *Heliotropium curassavicum* complex occurs in warm regions of the Western Hemisphere and is adventive in the Old World.

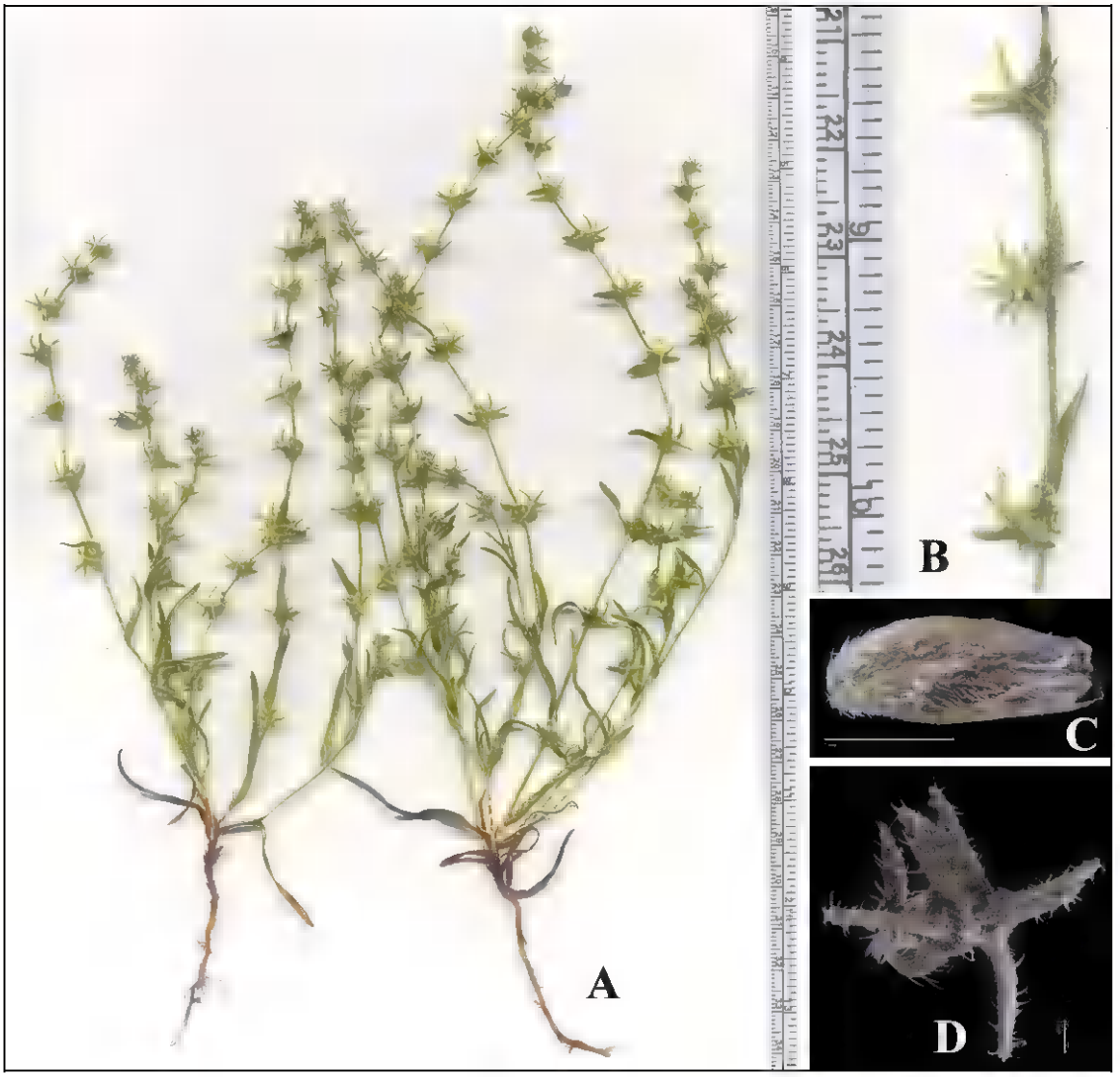

Figure 16. *Harpagonella palmeri*. (A & B) Var. *arizonica*, Bull Pasture, 7 Mar 2014. Nutlet and fruit, bar = 1 mm: (C) var. *palmeri*, nutlet, Monte Vista Ranch S of Ramona, San Diego Co., CA, 18 May 2006, *Rebman 12817* (SD 177861); (D) var. *arizonica*, face view of calyx enclosing the fruit, NE Sierra El Humo, Sonora, 7 May 2005, *Van Devender 2005-842* (ARIZ 377143); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/pectocarya/taxa/H_palmeri/

Alkali heliotrope was used by the Hia C-ed O'odham as a remedy for coughs and sore throat (Felger et al. 1992); by the Gila River Pimas to treat sore eyes, sores, and wounds (Russell 1908; Rea 1997); and by Seris to treat colds and stomachaches (Felger & Moser 1985).

OP: Quitobaquito, *Nichol 28 Apr 1939*. Rincon Spring, 13 Apr 1941, *McDougall 90*. William Spring, *Van Devender 30 Aug 1978*. Aguajita Spring, 6 Apr 1988, *Felger 88-276*.

CP: Agua Dulce Spring, 13 Jun 1992, *Felger 92-577*.

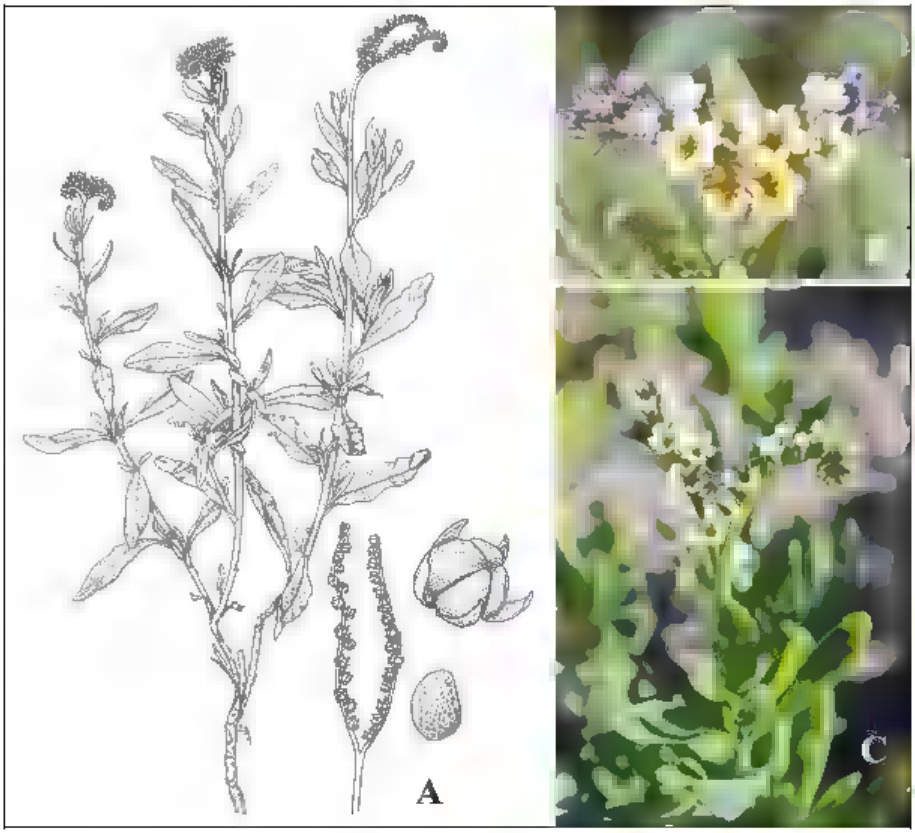

Figure 17. *Heliotropium curassavicum* var. *oculatum*. (A) By Lucretia Breazeale Hamilton. (B) Quitobaquito 15 Feb 2009. (C) Las Conchas, Puerto Peñasco, Sonora, 14 Feb 2014.

Johnstonella

Ephemerals or facultative perennials (two species); germinating, growing, and flowering during cooler seasons. Often with coarse, bulbous-based hairs.

Amphitropical in distribution: southwestern North America (11 species) and southern South America (2 species) (/www.sci.sdsu.edu/plants/johnstonella/taxa.html).

Johnstonella angustifolia (Torrey) Hasenstab & M.G. Simpson
[*Cryptantha angustifolia* (Torrey) Greene]
Narrow-leaf cryptantha, desert cryptantha. Figures 8F & 18.

Plants highly variable in size depending on soil moisture, several to 35 cm tall, the larger plants often globose and bushy. Inflorescences coiled to one side distally. Calyx lobes relatively slender, much longer than nutlets. Corollas often 2–3 mm wide. Nutlets heteromorphic (those in the flora area, or rarely homomorphic, the 4 nutlets of the same size), 4 per fruit, all alike except the nutlet toward the inflorescence axis almost always larger, the 4 nutlets more or less triangular, the

surfaces light brown, tuberculate (evenly dotted with tiny whitish bumps), the margins round-angled (rarely sharp-edged but not prominently knife-edged), the larger nutlet 1–1.4 mm long, the others (0.65) 0.8 (0.9) mm long.

One of the most widespread and abundant winter-spring ephemerals in the region. Many habitats including dunes, washes, creosotebush plains, bajadas, and rocky slopes; often especially large and robust on the Pinta Sands. It has been in the flora area for more than 13,500 years.

Dry regions of southwestern United States and Mexico in Baja California and Sonora south to the vicinity of Guaymas. This is one of those itchy plants that get in your socks and sleeping bag.

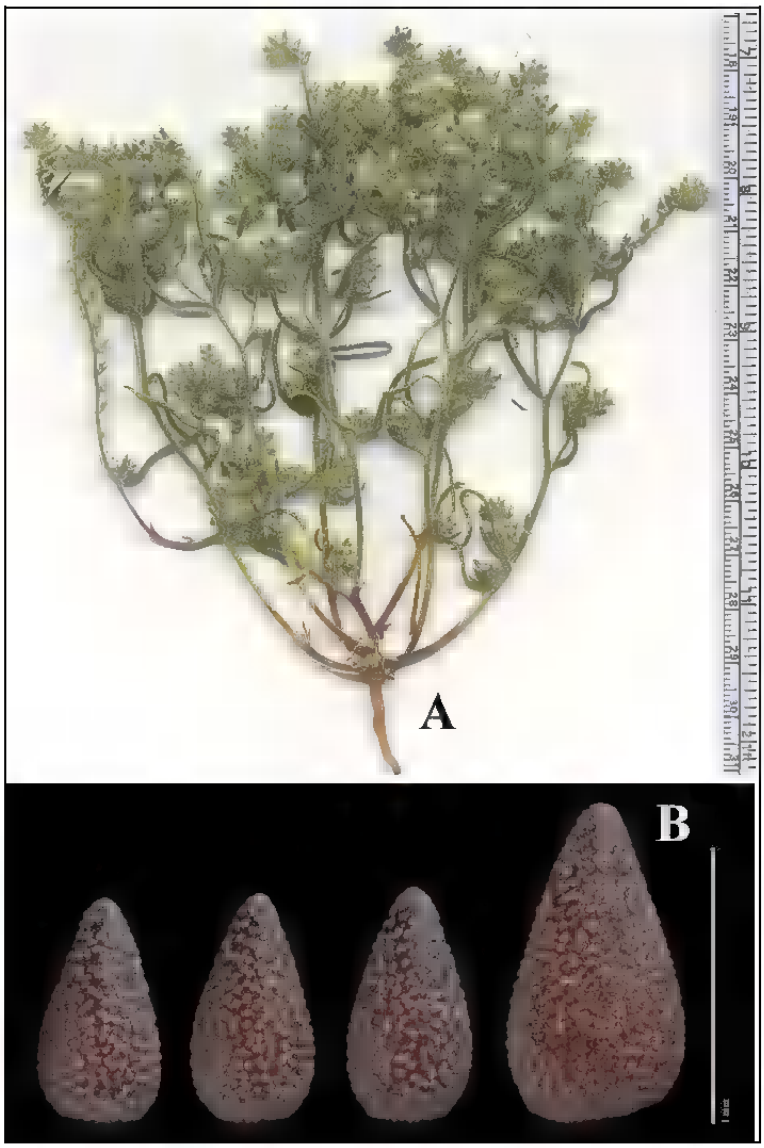

Figure 18. *Johnstonella angustifolia*. (A) Alamo Wash, 24 Mar 2008. (B) Dorsal view of heteromorphic nutlets, bar = 1 mm; near Cottonwood Springs Campground, Joshua Tree National Park, Riverside Co., CA, 1 Apr 2008, *Hasenstab 52* (SDSU 18687); by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/johnstonella/taxa/J_angustifolia/>

OP: 1 mi N of Sonoyta, 22 Mar 1941, *McDougall 17*. Quitobaquito, 14 Apr 1963, *Felger 7671*. Senita Basin, 26 Feb 1978, *Bowers 1093*. 2 mi E of Bates Well, 30 Mar 1979, *Bowers 1593*.

CP: Sandy soil, Pinacate Lava Fields, 20 Mar 1933, *Shreve 6219*. N of Las Playas, in malpais desert, *Darrow 15 Apr 1941*. Pinta Sands, 13 Mar 1983, *Eiber 39a*.

TA: Tinajas Altas, *Van Devender 5 Mar 1983*.

Johnstonella costata (Brandegee) Hasenstab & M.G. Simpson
[*Cryptantha costata* Brandegee]
Ribbed cryptantha

Stems erect, the branches somewhat stiff and straight (not as open and loose as in *Cryptantha barbigera* or *J. angustifolia*). Corollas 1–2 mm wide. Nutlets 4, homomorphic (or 1 sometimes larger), the margins knife-edged but not winged; inner face of nutlet flat; back of nutlet smooth and notably convex.

Not known from the flora area but should be sought on dunes and sand soils in the southwestern part of Cabeza Prieta and in the Tinajas Altas Region in the Lechuguilla Valley and west of the Tinajas Altas Mountains. The nearest known records are from the Yuma dunes near the southwest margin of the Tinajas Altas Region, the Mohawk Dunes, and the Gran Desierto dunes and sand soils in adjacent Sonora just south of Arizona (e.g., Felger 2000).

Dunes and sand soils in the Mojave and Sonoran Deserts: southwestern Arizona, Baja California, California, and Nevada.

Yuma Co.: Mohawk Dunes, *Darrow 23 Apr 1938*. Goldwater Range, SE corner of Yuma Dunes, 0.4 km N of Mexico border, 0.4 km NE of USMEX Hill, UTM 12 342400, 3585400, 121 m, rolling dunes, 13 Apr 1993, *Walter 67* (ASU).

Sonora: 20 mi (Mex 2) E of San Luis [Río Colorado], 9 Apr 1966, *Bezy 458*.

Johnstonella holoptera (A. Gray) Hasenstab & M.G. Simpson
[*Cryptantha holoptera* (A. Gray) J.F. Macbride]
Winged cryptantha. Figures 8G & 19.

Plants extremely variable in size; facultative ephemerals to perennials (probably short-lived) becoming woody at the base, the perennials most frequent at higher elevations. Herbage with conspicuously coarse hairs, the leaves gray-green. Inflorescences coiled to one side distally. Flowers often very fragrant, the corollas 3–4 mm wide. Nutlets 4, homomorphic, 1.2–2 mm long, light brown with a sharp-edged ribbon-like wing, 4 per fruit.

Granitic and basalt hills and mountains and sometimes along adjacent washes in the south-central and southwest parts of Cabeza Prieta, especially on north-facing slopes, canyons, and arroyos.

Southeastern California, western Arizona, northeastern Baja California, and northwestern Sonora.

Johnstonella holoptera is typically described as only possessing homomorphic nutlets. However, *J. inaequata* (I.M. Johnston) Brand, with heteromorphic nutlets, has been incorrectly synonymized with *J. holoptera* by various authors, most recently by Kelley and Wilkin (1993; Ronald B. Kelley, pers. comm. to R. Felger, 2014). *J. inaequata* occurs in southern California and southern Nevada to northwestern Arizona and southwestern Utah.

CP: 26 mi W of Papago Well, Tule Mts, 15 Apr 1941, *Benson 10791*. Tule Tank, 14 Apr 1992, *Harlan 291* (CAB). Cabeza Prieta Peak, S-facing side of summit, *Yeatts 24 Mar 1995* (CAB).

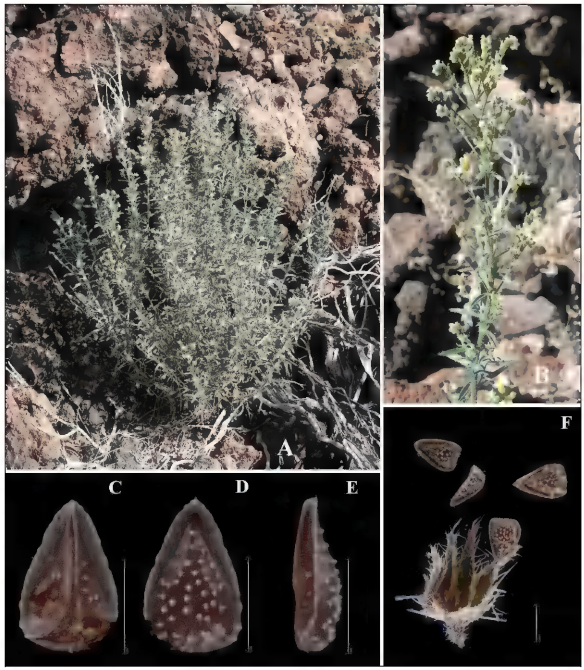

Figure 19. *Johnstonella holoptera*. (A & B) Near Red Cone campground, Pinacate Biosphere Reserve, Sonora, 3 Mar 2009. Calyx and nutlets, bar = 1 mm, Agua Chale, Baja California, 21 Apr 1960, *Moran 8212* (SD 54473): (C–E) ventral, dorsal, and lateral views; (F) calyx and nutlets; by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/johnstonella/taxa/J_holoptera/>

Johnstonella racemosa (S. Watson ex A. Gray) Brand
[*Cryptantha racemosa* (S. Watson ex A. Gray) Greene. *Eritrichium racemosum* S. Watson ex A. Gray]
Bushy cryptantha. Figures 8H & 20.

Ephemerals to perennial herbs or subshrubs (probably short-lived) to 0.5+ m tall, often woody at the base with several upright main axes, shredding bark, and short branches above; also flowering in the first season but these mostly do not survive the summer drought. Inflorescence branches not strongly coiled distally. Corollas 3–3.5 mm wide. Nutlets heteromorphic, 4 per fruit, light brown with narrow, cord-like margins, of similar shape and ornamentation but the larger nutlet 2 mm long, the others 1.1–1.4 mm long.

Granitic slopes of the Tinajas Altas Mountains, one record in Cabeza Prieta, and in adjacent areas in Sonora. It has been in the flora area for more than 11,000 years.

This desert species occurs in the Mojave Desert in California and Nevada, and southward in the Sonoran Desert to northern Baja California and northwestern Sonora. It is distinguished from the related *C. holoptera* by having non-coiled inflorescence branches and markedly heteromorphic nutlets with narrow, cord-like margins.

CP: Buckhorn Tank, ca. 35 mi S of Mohawk, 14 Jul 1955, *Ahles 9089* (ASC).
TA: Vicinity of Tinajas Altas, 1700 to 1900 ft, on cliffs, *Van Devender 5 Mar 1983.* †Butler Mts, calyx, nutlets, 10,360 ybp. †Tinajas Altas, calyces, nutlets, 8970 to 11,040 ybp (5 samples).

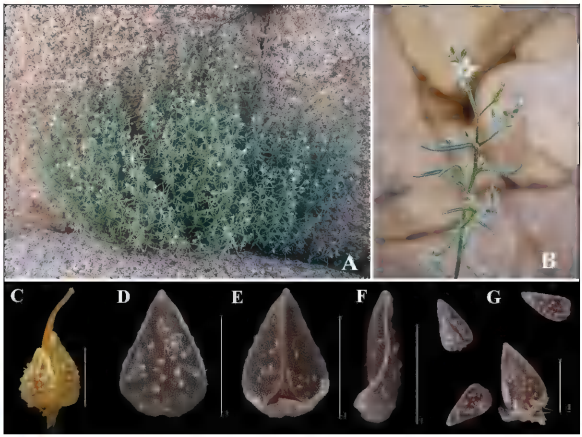

Figure 20. *Johnstonella racemosa.* (A & B) S of Cottonwood Springs, Joshua Tree National Park, Riverside Co., CA, *Hasenstab 68* (SDSU 18710). Fruit, calyx, and nutlets, bar = 1 mm: (C) fruit with heteromorphic nutlets, *Hasenstab 68*; (D–F) nutlet, left to right, dorsal, ventral, and lateral views, W slope of Providence Mts, San Bernardino Co., CA, 28 May 1941, *Wolf 10837* (SD 42216); (G) calyx and nutlets, Darwin Falls, Inyo Co., CA, 15 May 1931, *Hoffman 315* (SD 107309); by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/johnstonella/taxa/J_racemosa/>

Lappula

This genus includes more than 60 species in Eurasia and Susan Rolfsmeier's (2013) dissertation establishes 12 native and various non-native taxa in North America. North American taxa include two varieties of *L. occidentalis*: var. *occidentalis* with homomorphic nutlets and var. *stricta* with heteromorphic nutlets. The regional synonymized representative of var. *stricta* is the Rydberg species *L. leucotricha* (type from Pima County), which Ronald B. Kelley (pers. comm. to R. Felger, 2014) found in numerous locations collecting in southern Arizona in spring 2013, usually in wash habitats. He also collected the Tucson regional volcanic endemic *L. coronata* Greene, which is morphologically quite distinctive from var. *stricta* and recognized by Rolfsmeier (2013) as a distinct species. Rolfsmeier also shows that *L. redowskii* (Hornemann) Greene is restricted to Eurasia.

Lappula occidentalis (S. Watson) Greene var. **stricta** (S. Watson) S.J. Rolfsmeier
[*L. leucotricha* Rydberg]
Flat-spine stickseed. Figure 21.

Spring ephemerals with coarse hairs; taprooted; 1 to several or more erect, slender, major stems, branching mostly above the middle. Flowering branches raceme-like at maturity. Flowers small, pale blue or white. Fruits bur-like; nutlets 4 per fruit, heteromorphic, the body 2–2.3 mm long, ovate-triangular, the odd nutlet with barb-tipped spines separated at base, the other three nutlets with winged margins formed of stout, barb-tipped spines fused at base.

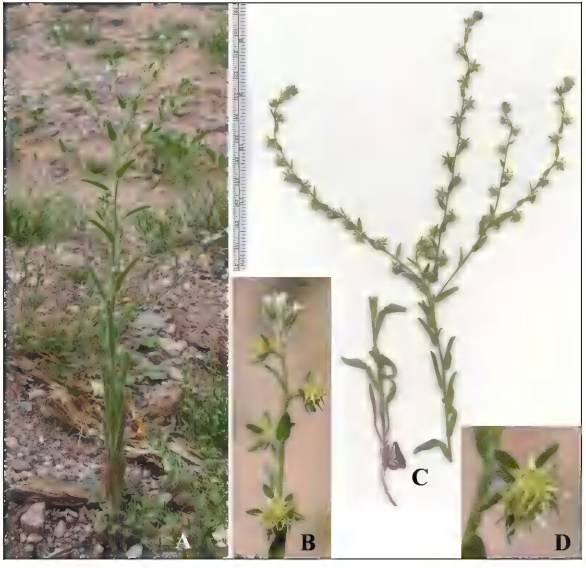

Figure 21. *Lappula occidentalis* var. *stricta*. (A) Alamo Well, 11 Mar 2014. (B & D) Victoria Mine, 1 Apr 2010. (C) Alamo Canyon, 11 Mar 2014.

Locally in sandy-gravelly and silty soils of washes and bajada plains, often beneath mesquites and in disturbed habitats. This or a similar *Lappula* has been in the Ajo Mountains for 22,000 years.

This species occurs from Sonora and Arizona eastward to Oklahoma and north to Montana, North Dakota, and British Columbia, although Rolfsmeier (2013: 151) states that, "*L. occidentalis*

was . . . problematic to circumscribe." Variety *stricta* occurs in Arizona, Idaho, Nevada, Oregon, Utah, and the Sonoran Desert in Mexico. As a genus in this floristic area, *Lappula* most likely represents a Pleistocene relict. *Lappula occidentalis* var. *stricta* tends to exist in ephemerally moist habitats such as shaded washes, riparian zones, roadsides, and ruderal areas, but it appears to be a native element of the flora (Ronald B. Kelley, pers. comm. to R. Felger, 2014).

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939* (ORPI). Quitobaquito, 17 Apr 1952, *Parker 7990.* Growler Wash at Bates Well Road, 30 Mar 1978, *Bowers 1152* (ORPI). 0.6 mi E of Lukeville, broad sandy wash, 20 Feb 1988, *Felger 88-06.* †Montezuma's Head, nutlets, 13,500 to 21,840 ybp (4 samples).

CP: Near Sheep Tanks, 28 Mar 1935, *Kearney 11029.* Cameron Wash, *Johnson 26 Mar 1960.* San Cristobal Wash, road from Bates Well to Papago Well, 31 Jan 1992, *Felger 92-5.* Charlie Bell Road near east Refuge boundary, 25 Feb 1993, *Felger 93-57.*

Nama – Purple mat

Cool-season ephemerals, first flowering as rosette plants, with slender stems. Leaves alternate and entire (those in the flora areas). Flowers solitary or in short cymose clusters. Calyx divided nearly or entirely to the base. Corollas readily deciduous, the lobes rounded and usually spreading. Stamens not exserted. Capsules many seeded.

Southwestern United States to tropical America and Hawaii; 55 species.

1. Plants semi-prostrate, matted; longer stem hairs 0.4 mm long; corollas bright lavender-pink; seeds dark brown, about as wide as long. ..... **Nama demissum**
1. Plants erect with ascending branches, with age sometimes spreading-prostrate but not matted; longer stem hairs 0.8–1.2 mm long; corollas pale lavender to purple; seeds yellowish, about twice as long as wide……..... **Nama hispidum**

Nama demissum A. Gray var. **demissum**
Purple mat. Figure 22.

First flowering as rosette plants, often developing slender stems 2–10 cm long, prostrate to prostrate-ascending at tips. Stem hairs (0.3) 0.4 (0.5) mm long, often not straight, and relatively soft. Leaves 1.5–4 cm long, narrowly spatulate, gradually narrowed to a winged petiole, the upper leaves smaller, sessile, and mostly in compact terminal clusters. Corollas bright lavender-pink (rarely white), 10–12 mm long. Basal portion of filaments (the part fused to corolla tube) narrowly winged. Styles 2, distinct to the base. Seeds chunky and ovoid, dark brown at maturity, 0.55–0.6 × 0.5 mm, the surface lumpy with transverse grooves or pits.

Mostly along washes and gravelly soils of bajadas and plains, often in open, otherwise barren areas such as desert pavement. Localized in portions of the western part of Cabeza Prieta and the Tinajas Altas Range.

California to Baja California Sur, Utah, Arizona, and northwestern Sonora. The plants are more compact, closer to the ground, generally smaller and with brighter and darker-colored flowers than the more common *N. hispidum*. Two other varieties of *N. demissum* occur in the Baja California Peninsula and California.

CP: E side of Tule Mts, 22 Mar 1992, *Harlan 112* (CAB). 1 km N of Tule Well, 11 Apr 1993, *Felger 93-442.*

TA: 1 km SE of mouth of Borrego Canyon, 18 Mar 1998, *Felger 98-112.*

Figure 22. *Nama demissum* var. *demissum*. Cinder flats ENE of Red Cone campground, Pinacate Biosphere Reserve, Sonora, 7 Mar 2009.

Nama hispidum A. Gray
[*N. hispidum* var. *spathulatum* (Torrey) C.L. Hitchcock. *N. coulteri* A. Gray. *N. hispidum* var. *coulteri* (A. Gray) Brand]
Morada; bristly nama. Figure 23.

First flowering as rosette plants, often developing stems 5–30 cm long, erect to ascending or spreading with age. Larger stem hairs (0.8) 1–1.2 mm long, bristly, and straight. Leaves 1.5–4.5 cm long, narrowly spatulate, gradually narrowed to a winged petiole, the upper leaves smaller and sessile. Corollas lavender, (10) 13–15 mm long. Styles 2, distinct to the base. Seeds 0.5–0.6 mm long, ellipsoid-ovoid, about twice as long as wide, yellowish, the surface minutely reticulate.

Widespread and common across the flora area, especially washes, sandy flats, and bajadas.

Southeastern California to Baja California Sur, western Texas, Nevada, Utah, and Arizona to northern mainland Mexico from Sonora and Sinaloa to Coahuila and Nuevo León. The varieties do not seem to be well marked, although if recognized, those in southern Arizona are var. *spathulatum* (Torrey) C.L. Hitchcock.

OP: Alamo Canyon, *Nichol 26 Mar 1939*. Quitobaquito, 18 Feb 1978, *Fay 744*. Puerto Blanco Drive (two-way section) 5.3 mi W of Hwy 85, 26 Feb 1978, *Bowers 1073*.

CP: 1 mi N of Cabeza Prieta Tanks (Simmons 1966). San Cristobal Wash, 20 Mar 1992, *Harlan 7* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-431*. 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002*.

TA: Coyote Water, 25 Oct 2004, *Felger 04-52*. Surveyors Canyon, 29 Mar 2010, *Felger 10-214*. Frontera Canyon, 18 Mar 1998, *Felger* (observation).

Pectocarya – Comb-bur

Small, cool-season ephemerals. Leaves linear to narrowly oblanceolate or narrowly elliptical, often small, cotyledons and first pair opposite, appearing as a basal rosette, the others alternate Inflorescences of scorpioid cymes, not tightly coiled distally or only moderately so (those in the flora

area), potentially appearing racemose in age. Flowers minute, opening at maturity (chasmogamous) or sometimes not opening (cleistogamous); corollas white, sometimes with a yellow throat. Fruits monomorphic or dimorphic (basal and cauline fruits dissimilar). Nutlets homomorphic or heteromorphic (nutlets within a fruit dissimilar), usually 4, in 2 pairs spreading apart like miniature gaping jaws, the margins with bristles and/or teeth. (Key and descriptions based in part on Guilliams et al. 2013).

Western North America from southwestern Canada (British Columbia) to northwestern Mexico (Baja California Sur and Sonora), and South America in Bolivia, Peru, Chile, and Argentina; 13 species, 14 taxa.

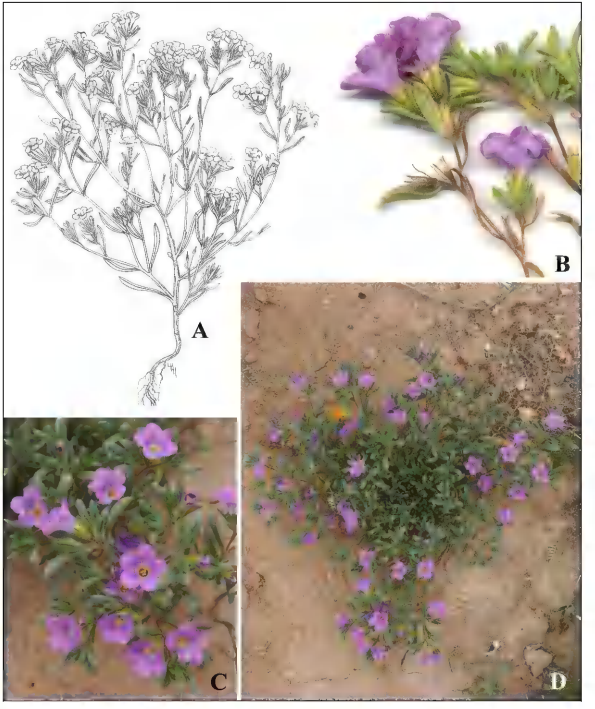

Figure 23. *Nama hispidum.* (A) By Lucretia Breazeale Hamilton. (B) Ajo, Pima Co., 17 Mar 2003. (C & D) Hwy 85, 25 mi N of Ajo, 8 Mar 2008.

1. Cauline fruits with nutlets not all alike (nutlets heteromorphic)—the pairs dissimilar in size and the margins also dissimilar, and each nutlet within a pair slightly different.

2. Pedicel of cauline fruits not fused to lower, inner nutlet; nutlets of basal fruits and cauline fruits similar (fruits monomorphic), the nutlets of cauline fruits all in one plane ..... **Pectocarya anisocarpa**

2. Pedicel of cauline fruits fused to lower, inner nutlet; the nutlets of basal fruits and cauline fruits dissimilar (fruits dimorphic), the nutlets of cauline fruits in two planes ..... **Pectocarya heterocarpa**

1. Cauline fruits with nutlets all alike (or essentially so, nutlets homomorphic).

3. Nutlets straight or only slightly recurved, the nutlet margin with a conspicuous wing of tissue, the wing toothed, wing and teeth lighter colored (often yellowish) than body of nutlets ..... **Pectocarya platycarpa**

3. Nutlets conspicuously recurved, the nutlet margin without wing of tissue or wing very narrow and about the same color as the body ..... **Pectocarya recurvata**

Pectocarya anisocarpa Veno
Unequal comb-bur

Plants prostrate to decumbent, branched from base. Flowers opening at maturity (chasmogamous); corollas (limb width) 0.5–1 (1.5) mm wide and 0.5–2.3 mm long. Fruits within a plant similar (monomorphic). Nutlets within a fruit dissimilar (heteromorphic). Nutlets away from inflorescence axis winged, wing undulate to widely-toothed, with uncinate bristles. Nutlets toward the inflorescence axis smaller and with wing reduced or absent. All nutlets with a pectinate fringe of uncinate bristles distally.

This species, described in Guilliams et al. (2013), is likely to be in the northern part of the flora area. It occurs along the I-8 highway west of Gila Bend.

Central California to southwestern Utah, southward through central and southern Arizona, and rare in Baja California.

Pectocarya heterocarpa (I.M. Johnston) I.M. Johnston
Mixed-nut comb-bur. Figure 24.

Plants prostrate to ascending, branched from base. Cauline and basal flowers dissimilar. Cauline flowers open at maturity (chasmogamous) and fragrant. Corollas white with a yellow throat, 1.5–2 mm wide, the stigma green. Fruits within a plant dissimilar (dimorphic). Nutlets within cauline fruits dissimilar (heteromorphic), often moderately curved or slightly curled inward (not outward), one pair larger, winged and with marginal teeth, the other pair not winged and lacking marginal teeth, each nutlet within a pair slightly different. Lowermost flowers often cleistogamous.

Widespread on sandy soils, especially low, stabilized dunes and sand flats, washes and their floodplains, bajadas, and sometimes hills and mountains. Its history in the flora area extends to 10,400 years.

Southern California to western Texas and Utah, and southward to Baja California and northern Sonora.

OP: Road to Walls Well, 26 Mar 1941, *McDougall 40*. Near Dripping Springs, 16 Apr 1952, *Parker 7936*. Quitobaquito, 6 Apr 1988, *Felger 88-270*. †Puerto Blanco Mts, nutlets, 990 ybp.

Figure 24. *Pectocarya heterocarpa*. CD Trail near Engineer Canyon, Burro Mts, Grant Co., NM, 20 Apr 2010: (A) mature plant; (B) nutlets, note two are broadly winged and two are wingless; (C) flower. Photos by Russell Kleinman (gilaflora.com).

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3953*. Pinacate Lava Flow, sand hill, 1 Feb 1992, *Felger 92-18*. Camino del Diablo at San Cristobal Wash, 26 Feb 1993, *Felger 93-109*.
TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-137*. †Butler Mts, nutlets, 10,360 ybp.

Pectocarya platycarpa (Munz & I.M. Johnston) Munz & I.M. Johnston
Broad-winged comb-bur. Figure 25.

Plants erect to widely ascending, and branched from base. Flowers open at maturity (chasmogamous); corollas 1.25–2 mm wide. Fruits within a plant similar (monomorphic). Nutlets homomorphic or heteromorphic, straight or slightly recurved, the margins yellow and winged, the wing wide with conspicuous teeth. When heteromorphic, those nutlets toward the inflorescence axis smaller and with reduced ornamentation. Distinguished from other regional comb-burs by the generally larger-sized plants, larger and wider nutlets, and fewer and larger teeth on the nutlet wing.

Widespread including washes, desert flats, bajadas, and rocky slopes. It was at Tinajas Altas 10,600 years ago.

Northern Sonora, Baja California, Arizona, southeastern California, southern Nevada, and southwestern Utah.

OP: Puerto Blanco Mts, *Nichol 25 Feb 1939*. Alamo Canyon, 14 Mar 1941, *Benson 10664*. Near Dripping Springs, 16 Apr 1952, *Parker 7935*. Quitobaquito, 29 Mar 1988, *Felger 88-127*. Aguajita Wash, *Beale 8 Apr 1988* (ORPI).
CP: Growler Mts above Charlie Bell Wash, 1700 ft, 3 Apr 1992, *Whipple 3949*. Cristobal Wash, 11 Apr 1992, *Harlan 149* (CAB). Wash below Heart Tank, 27 Feb 1993, *Felger 93-167* (CAB).

Figure 25. *Pectocarya platycarpa*. (A) Kuakatch Wash near Hwy 85, 13 Feb 2005. Nutlets, bar = 1 mm: (B) dorsal and (C) ventral view, 3 mi S of Ajo on Hwy 85, 31 Mar 1962, *Howe 3182* (SDSU 04020); by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/pectocarya/taxa/P_platycarpa/>

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-137A*. †Tinajas Altas, nutlets, 10,600 ybp.

Pectocarya recurvata I.M. Johnston
Arched comb-bur. Figure 26.

Plants erect to ascending, branched from base. Flowers open at maturity (chasmogamous); corollas 0.75–2 mm wide. Fruits within a plant similar (monomorphic). Nutlets within a fruit similar (homomorphic), relatively small, narrow, conspicuously recurved (arched or curled back), the margins not winged or with a very narrow wing about the same color as the nutlet body, the teeth distinct.

Widespread in Organ Pipe and the east side of Cabeza Prieta; washes, desert flats, bajadas, and rocky slopes.

Northern Sonora, Baja California, southeastern California, Arizona, southern Nevada, New Mexico, and southern Utah.

OP: Near Dripping Springs, 16 Apr 1952, *Parker 7936A*. Canyon Diablo, 13 Feb 1978, *Bowers 1060*. Quitobaquito, 29 Mar 1988, *Felger 88-126*.

CP: S of Camino del Diablo on road to Agua Dulce Pass, 19 Mar 1987, *Elias 10198*. Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, *Felger 93-362*. Childs Mt, 2240 ft, 25 Feb 1993, *Felger 93-32A*.

Figure 26. *Pectocarya recurvata.* (A) Alamo Wash, 5 Mar 2014. (B) Nutlets, Van Winkle Spring, Mohave National Preserve, San Bernardino Co., CA, 19 Mar 2004, photo by Jim Andre (CalPhotos). (C) Nutlets, bar = 1 mm, Anza-Borrego State Park, San Diego Co., CA, 28 Mar 1998, *Young 12* (SDSU 12802), by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/pectocarya/taxa/P_recurvata/>

Phacelia

The phacelias in the flora area are glandular pubescent and can cause unpleasant dermatitis, and most are stinky. Cool-season ephemerals and one perennial (*P. ramosissima*). Leaves mostly alternate, entire, pinnate or bipinnate, and petioled (at least the lower, larger leaves). Inflorescences of scorpioid cymes, coiled distally except in *P. neglecta*. Calyces lobed almost to the base. Corollas lavender, blue, or white. Seeds 4 (seldom fewer) or many.

Western hemisphere, with greatest diversity in western North America; 175 species.

There are reports that young, tender plants of these spring ephemerals were cooked as greens, but these plants, especially older ones, can be stinky and highly irritating to the skin. Rea (1997) reports that the Gila River Pimas made use of phacelias cooked as greens, but these were not highly esteemed.

1. Perennials, often woody at the base; Ajo Mountains …….. **Phacelia ramosissima**
1. Winter-spring ephemerals; widespread including the Ajo Mountains.

2. Seeds solid, more or less terete in cross-section, similar on all sides.

3. Leaf blades pinnate to pinnatifid, more than twice as long as wide.

4. Seeds many per capsule ..... ……. **Phacelia affinis**
4. Seeds 4 per capsule ……..... **Phacelia distans**

3. Leaf blades more or less ovate, shallowly lobed; about as long as wide.

5. Stems thick and succulent; inflorescences generally not taller than the leaves; seeds 0.7–0.9 mm long …….. **Phacelia neglecta**

5. Stems not noticeably thick and succulent; inflorescences taller than the leaves; seeds to 0.5 mm long..... **Phacelia rotundifolia**

2. Seeds boat-shaped, one side of each seed excavated (with a cavity) on either side of a septum (a ridge down the middle), the other side of the seed convex.

6. Fruiting pedicels 4–7 mm long, longer than the capsules; fruiting sepals 5–6.5 mm long, about twice as long as the capsules. ..... **Phacelia pedicellata**
6. Fruiting pedicels mostly 1–1.5 mm long, shorter than capsules; fruiting sepals 3–5 mm long, about as long to ¼ longer than the capsules.

7. Seeds 2.2–3.5 mm long, red-brown, the margins and ventral surface of the same color as the seed body (back). ..... **Phacelia crenulata**
7. Seeds 1.5–3 mm long, the margins and ventral surface paler (tan) than, and sharply differentiated from, the darker brown seed body (back).

8. Stamens exserted (conspicuously longer than the corollas). ..... **Phacelia bombycina**
8. Stamens often not exserted (as long as or shorter than the corollas). ...**Phacelia coerulea**

Phacelia affinis A. Gray
Limestone phacelia. Figure 27.

Leaves mostly basal and on the lower stems, (1.5) 3–6 cm long, pinnately lobed to pinnatifid, mostly narrowly oblong; upper leaves reduced. Inflorescences branches slightly to moderately curled distally. Flowers white, occasionally pale purple, with a pale yellow-green throat. Seeds many, nearly 1 mm long, solid, similar on both sides, transversely corrugated.

Mostly in the northern part of the Organ Pipe, wash banks at lower elevations, and rocky slopes at middle to upper elevations in the Ajo and Puerto Blanco Mountains.

Arizona to northwestern Sonora, southwestern New Mexico, southwestern Utah, southern Nevada, and southeastern California to Baja California Sur.

OP: Estes Canyon, 25 Feb 1978, *Bowers 1069* (ORPI). SE Puerto Blanco Mts, slopes above main campground, *Rutman 31 Mar 1998* (ORPI). Kuakatch Wash, 0.5 mi E of Hwy 85, *Rutman 9 Apr 1998* (ORPI).

Phacelia bombycina Wooton & Standley
Mangas Spring phacelia. Figure 28.

Leaves oblong to ovate, pinnately lobed, cleft, or crenate. Inflorescence branches strongly coiled distally. Flowers nearly sessile. Sepals 2.5 mm long. Corollas pale purple. Stamens exserted. Seeds 4 per capsule, probably 1.5 mm long; outer surface dark brown, convex, and alveolate (minutely pitted and reticulate); inner surface and margins light tan; inner surface excavated on each side of a prominent ridge, the ridge prominently corrugated (lumpy) on one side, the margins less prominently corrugated.

Known from a single record in Cabeza Prieta (perhaps more common since the plants superficially resemble those of *P. crenulata*). Also recorded in the mountains near Ajo and northward and eastward in Arizona. Arizona, southwestern New Mexico, northern Baja California, northern Sonora, and probably northwestern Chihuahua.

CP: Scarface Mt, UTM 3565000N, 317500E 12, 1650 ft, limestone and coarse sand, *Autenreith 20 Mar 1992* (ASC, det. N.D. Atwood, 14 Jan 2004).

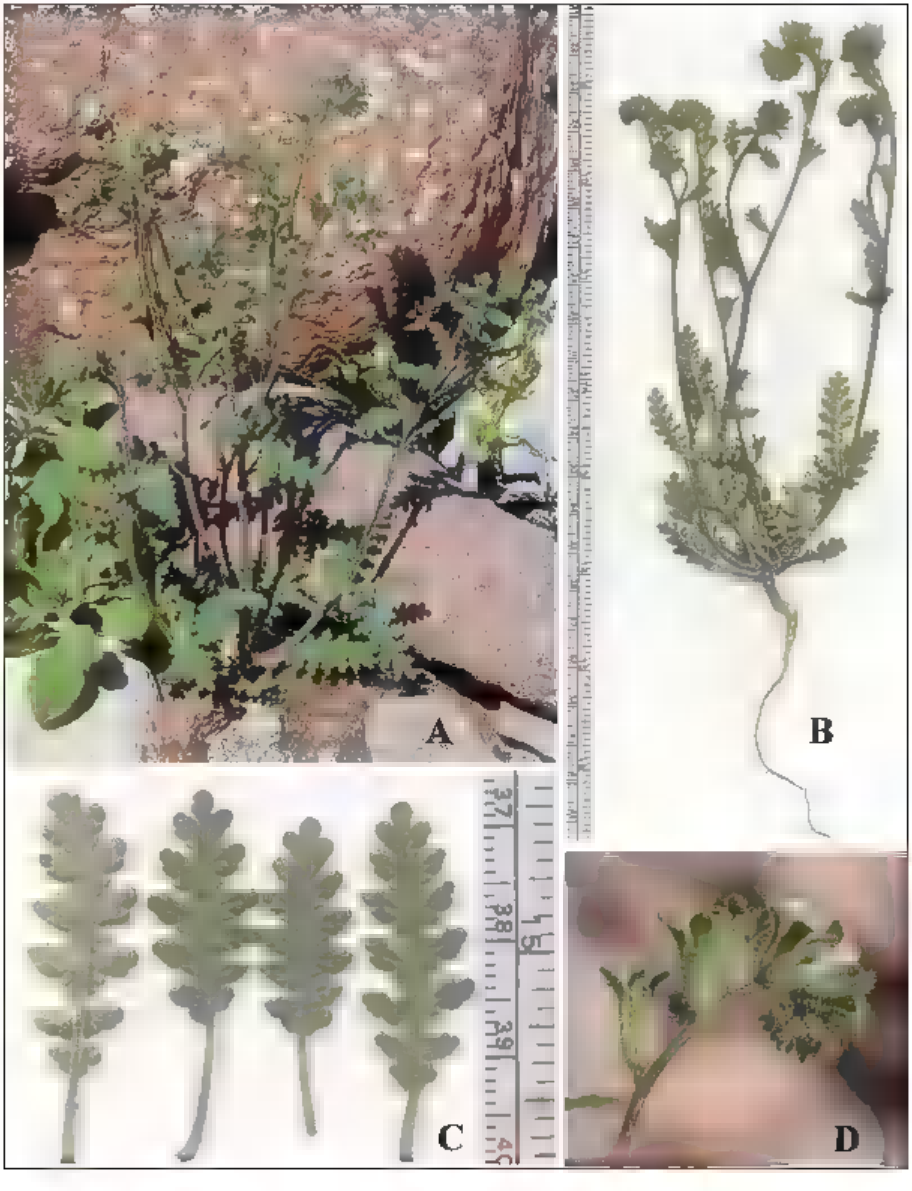

Figure 27. *Phacelia affinis*. Alamo Well: (A) 11 Mar 2014; (B & C) 16 Mar 2014; (D) 26 Feb 2014.

Figure 28. *Phacelia bombycina.* (A) Hills west of Coffeepot Mtn, Sauceda Mts, Pima Co., 25 Feb 2012. (B) Courthouse Butte, Sedona, Yavapai Co., 17 Feb 2003, photo by Max Licher (SEINet).

Phacelia coerulea Greene
Skyblue phacelia. Figure 29.

Leaves oblong to ovate, pinnately lobed, cleft, or divided. Inflorescence branches coiled to one side distally. Flowers whitish to pale lavender with a white center. Stamens often not exserted (as long as or shorter than the corollas). Seeds 4 per capsule, 1.5–3 mm long; outer surface dark brown, convex, and alveolate (minutely pitted and reticulate); inner surface and margins paler (tan) than and sharply differentiated from dark brown body (back), the margins incurved; inner surface excavated on each side of a prominent ridge, and corrugated (lumpy) on one side.

Widely scattered in Organ Pipe and in the eastern part of Cabeza Prieta and at Cabeza Prieta Tanks.

Southern Arizona to western Texas and Utah, southeastern California, Chihuahua and northern Sonora.

Some plants in the flora area identified as *P. coerulea* resemble *P. crenulata* var. *ambigua*, but *P. coerulea* tends to have more slender stems, the leaves tend to have larger and more rounded lobes, the corollas are paler, the stamens usually shorter than the corollas indicating autogamous (selfing) flowers (plants clearly resembling *P. coerulea* sometimes have well-exserted stamens, especially when well-watered), and the seeds are not as smooth and the margins are distinctive. In Alamo Canyon *P. coerulea* grows intermixed with *P. crenulata*, and the plants are easily distinguished; *P. coerulea* also occurs intermixed with *P. affinis* and *P. distans*.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10824*. Alamo Canyon, *Nichol 14 Mar 1939*. Arch Canyon, 5 Apr 1978, *Bowers 1172* (ORPI). Hills to E of Senita Basin, *Rutman 10 Mar 1998* (ORPI).
CP: Cabeza Prieta Tanks, 6 Apr 1979, *Lehto L 23535* (ASU).

Figure 29. *Phacelia coerulea*. Alamo Well, 11 Mar 2014.

Phacelia crenulata Torrey ex S. Watson var. **ambigua** (M.E. Jones) J.F. Macbride
[*P. ambigua* M.E. Jones. *P. ambigua* var. *minutiflora* (J.W. Voss) N.D. Atwood]
Desert heliotrope. Figure 30.

Herbage stinky and irritating, sticky-viscid with spreading white hairs, and minutely glandular above. Stems often 10–30 (45+) cm tall, mostly erect, simple or several-branched. Larger leaves basal and often also on the lower stem, often 3–15 cm long, pinnatifid or the lower segments cleft to the midrib or into separate leaflets; leaves reduced upwards. Inflorescence simple to several-branched, coiled to one side distally. Flowering and fruiting pedicels often 1–1.5 mm long. Flowers moderately fragrant; corollas lavender with a white tube, 4–8 mm long. Stamens exserted. Fruiting sepals 3–5 mm long, about as long as to ¼ longer than the capsules. Seeds 4 per capsule, 2.2–3.5 mm long, boat-shaped, red-brown, alveolate (minutely pitted and reticulate), the outer surface convex, the inner surface excavated on each side of a prominent ridge, the ridge corrugated on one side, the margin smooth (not corrugated) and not differentiated from the body (back).

This is the most abundant and widespread phacelia in the region, occurring in many habitats including washes, canyons, bajadas, plains, dunes and rocky slopes often to their summits. Fossils more than 8000 years old were found in the Ajo Mountains.

Contact with *Phacelia crenulata* and other *Phacelia* species can cause phacelia dermatitis (*Dermatitis venenata*), which is a painful rash similar to poison ivy rash (Berry et al. 1962, Munz 1932). About 10 percent of the general population is susceptible. In years when *Phacelia crenulata* is abundant, visitors afflicted with the rash arrive at the Organ Pipe visitor center asking about its cause. In severe cases, victims need hospitalization.

The *ambigua* taxon occurs in Arizona to northwestern Sonora, southern Nevada, and southeastern California to Baja California. The taxonomy of the *P. crenulata* complex can be complicated and confusing: calling the flora area population *P. crenulata* var. *ambigua* seems to be the most reasonable choice, and consistent with The Jepson Manual (Patterson et al. 2003). Several varieties of *P. crenulata* are often recognized, extending across much of southwestern North America.

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939* (ORPI). Puerto Blanco Mts, *Nichol 24 Feb 1939* (det. *P. minutiflora*, Atwood & Smith 1994). Road to Dripping Springs, 20 Mar 1941, *McDougall 2*. Near road 5 mi N of Sonoyta, 22 Mar 1941, *McDougall 16* (det. as *P. minutiflora*, Atwood & Smith 1994). Quitobaquito, 18 Mar 1945, *Gould 2999* (det. *P. minutiflora*, Atwood & Smith 1994). Bajada at Sierra de Santa Rosa, 11 Feb 1978, *Bowers 1028*. 2 mi E of Bates Well, 30 Mar 1979, *Bowers 1596* (det. as *P. ambigua*, Atwood & Smith 1994). †Alamo Canyon: seed (2.9 mm long, margin not well differentiated), 1150 ybp; seed, margin not differentiated, 8130 ybp

CP: Sam Clark Mine, (Little Ajo Mts), 1800 ft, *Simmons 10 Mar 1963*. Tuseral Tank (Simmons 1966). Dunes, S of Las Playas, lava field, 10 Apr 1978, *Reeves 6766* (ASU). E side of Pinacate Lava, 21 Mar 1992, *Harlan 98*. Charlie Bell Road near E boundary of Refuge, 9 Apr 1993, *Felger 93-318*. Cabeza Prieta Peak, S side summit, 2550 ft, 24 Mar 1995, *Yeatts 3665* (CAB).

TA: Tinajas Altas: Mar 1937, *Harbison 16820*; *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-128*. 0.3 mi E of Fortuna Mine, Gila Mts, 760 ft, Van Devender 31 Dec 1972 (det. *P. ambigua*, Atwood & F.J. Smith 1994).

Phacelia distans Bentham
Caterpillar phacelia, fernleaf phacelia. Figure 31.

Plants simple to often much-branched and spreading, the stems slender and leafy, 15–45+ cm long including inflorescences. Herbage moderately sticky with conspicuous white hairs, sometimes with swollen white bases, and also sessile glands, golden when fresh. Leaves fern-like, 6–17 cm long, 1- or 2-times pinnatifid, the segments pinnately lobed or toothed to pinnatifid. Inflorescences coiled to one side distally. Calyx lobes moderately enlarging in fruit, reaching 6+ mm long. Corollas

(7) 8–9.5 mm long, pale violet to blue, the lobes spreading. Seeds 4 or fewer, 2 mm long, solid, and similar on both sides.

Widespread in Organ Pipe and the eastern part of Cabeza Prieta; washes, bajadas, canyons, and rocky slopes including higher elevations. Often growing in the protection of spiny shrubs.

In many life zones, western and southern Arizona, and western and northern Sonora, southern California, Baja California, and southern Nevada.

Figure 30. *Phacelia crenulata* var. *ambigua*. (A) Hwy 2 near Los Vidrios, Pinacate Biosphere Reserve, Sonora, 17 Mar 2014. (B–D) Bates Mts, 2 Mar 2008.

Figure 31. *Phacelia distans*. (A) Alamo Well, 11 Mar 2014. (B) Trail to Victoria Mine, Puerto Blanco Mts, 4 Mar 2008. (C) Victoria Mine Trail, 15 Mar 2008.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10853*. Alamo Canyon, *Nichol 4 May 1939*. Bates Well, 22 Apr 1942, *Cooper 731*. Aguajita, 6 Apr 1988, *Felger 88-280*. Kuakatch Wash, E Monument boundary, *Rutman 4* Apr 1998 (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-284*.

CP: Papago Well, *Crooks 31 Mar 1937*. Agua Dulce Springs (Simmons 1966). San Cristobal Wash, 27 Mar 1976, *McManus 661*. 2 mi S of Camino del Diablo on E boundary of Refuge, 26 Feb 1993, *Felger 93-79*.

Phacelia neglecta M.E. Jones

Alkali phacelia. Figure 32.

Plants semi-succulent, often less than 6–8 cm tall, the root and main stem notably thick. Leaves semi-succulent, petioled, the blades mostly 5–25 mm wide, broadly ovate to orbicular, the margins wavy to shallowly toothed. Corollas white. Unlike most phacelias, the plants are not stinky and the inflorescences with relatively few flowers, not appearing coiled distally. Seeds numerous, 0.7–0.9 mm long, solid, similar on both sides, resembling tiny insect pupae.

Western part of Organ Pipe and widely scattered through Cabeza Prieta and Tinajas Altas. Generally localized on desert pavements and sandy soils, often in otherwise nearly barren areas.

Western Arizona, northwestern Sonora, southeastern California, and southern Nevada.

OP: Flats N of Custom House, 1 mi N of Sonoyta (Arizona), 22 Mar 1941, *McDougall 18*. 3 mi S of Growler Mine, 21 Mar 1941, *McDougall 93*. 2 mi WSW of Bates Well, 30 Mar 1978, *Bowers 1128* (ORPI). 8.6 mi W of Hwy 85 on road to Quitobaquito, 2 Mar 1985, *Van Devender 85-8*.

CP: Cabeza Prieta Tanks, 6 Apr 1979, *Lehto L23540* (ASU). SE of Las Playas, desert pavement, 10 Apr 1978, *Lehto L22455* (ASU). Packrat Hill, 25 Feb 1993, *Felger 93-59*. 1 km N of Tule Well, 11 Apr 1993, *Felger 93-439*.

TA: E margin of Davis Plain, W side of Tinajas Altas Mts, W branch of Camino del Diablo, decomposed granite pediment directly downslope from rocky hill, 20 Feb 2005, *Felger 05-62*.

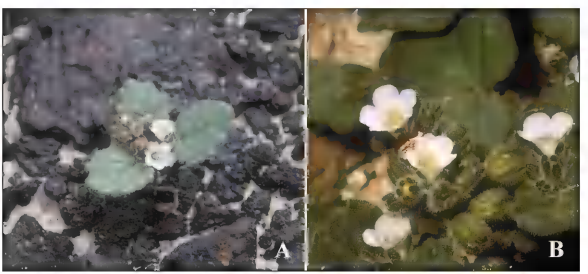

Figure 32. *Phacelia neglecta*. (A) Mojave National Preserve, San Bernardino Co., CA, 2010, photo by Genevieve K. Walden (SEINet). (B) Chocolate Mts, Imperial Co., CA, 1999, photo by Donald Myrick (CalPhotos).

Phacelia pedicellata A. Gray
Pedicellate phacelia. Figure 33.

Plants robust, stems often 10–45+ cm long, relatively thick and semi-succulent, and leafy. Herbage pale green, viscid glandular-hairy and notably stinky. Leaves 5–16+ cm long, pinnatifid to pinnately compound, and semi-succulent. Inflorescence coiled to one side distally. Flowers on slender pedicels, the fruiting pedicels 4–7 mm long. Calyx lobes elongated; fruiting sepals 5–6.5 mm long, about twice as long as capsules. Corollas pale lavender-blue. Seeds 4 per capsule, 2.5–3.1 mm long, boat-shaped, red-brown; outer surface convex and pitted; inner surface excavated both sides of a prominent ridge.

Figure 33. *Phacelia pedicellata*. (A) Near Red Cone campground, Pinacate Biosphere Reserve, Sonora, 7 Mar 2009. (B & C) Drainage NW of Kino Peak, Bates Mts, 20 Mar 2005. (D & E) Viscid, glandular-hairy stem and leaf blade, Estes Canyon near trailhead, 7 Mar 2014.

Scattered across the flora area including the Ajo Mountains, often in sandy-gravelly washes and shallow soils on tuff. This species, *Chenopodium watsonii*, and *Clerodendron coulteri* (*Tetraclea coulteri*) are the stinkiest plants in the flora area.

Western Arizona, northwestern Sonora, southeastern California, and eastern Baja California.

OP: Arch Canyon, 28 Mar 1965, *Niles 552*. Dripping Springs, *Wirt 5 Mar 1991* (ORPI). Estes Canyon, *Rutman 15 Apr 1998* (ORPI). Wash 1.2 mi NW of Kino Peak, 20 Mar 2005, *Rutman 2005-0320-9* (ORPI).

CP: T13S, R13W, SE¼, 26 Feb 1977, *Irwin 93* (ASU).

TA: Tinajas Altas, canyon bottom E of tinajas, 19 Mar 1998, *Felger 98-145*.

Phacelia ramosissima Douglas ex Lehmann
[*P. ramosissima* var. *latifolia* (Torrey) Cronquist]
Branching phacelia. Figure 34.

Perennial herbs often to 1 m or more wide. Leaves pinnately lobed to twice-divided. Inflorescences coiled to one side distally. Corollas pale blue. Seeds 2–4 per capsule, probably 2.5–3 mm long, pitted, and with a ventral ridge but scarcely excavated.

Figure 34. *Phacelia ramosissima*. (A & C) Base of N-facing cliff above Bull Pasture, 10 Apr 2005. (B) Catalina State Park, Pima Co., 22 Feb 2009, photo by Patrick Alexander (SEINet).

Middle to higher elevations in the Ajo Mountains, in coarse alluvium along washes, in shady sites, and under trees; apparently not widespread and not common.

This species occurs from Washington to Baja California, Utah and Arizona, but generally not in deserts. Four varieties are sometimes recognized; var. *latifolia* is the southernmost one.

Robust plants of *P. distans* in the Ajo Mountain superficially resemble *P. ramosissima*. Above Bull Pasture on 10 April 2005, *P. ramosissima* was in bud and just beginning to flower while the *P. distans* plants had dry fruits.

OP: Alamo Canyon: 15 Dec 1939, *Harbison 26261*; 2000 ft, *Tinkham 18 Apr 1942*. Bull Pasture, 2800 ft, perennial, flowers blue, 2 May 1978, *Bowers 1270* (ARIZ, annotated as *P. cryptantha* by Richard Halse, 1999, but the label says "perennial" and *P. cryptantha* is an ephemeral and is not known from Organ Pipe). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-265*.

Phacelia rotundifolia Torrey ex S. Watson
Roundleaf phacelia. Figure 35.

Plants generally less than 15 cm tall and often much smaller. Leaf blades more or less ovate, shallowly lobed, about as long as wide, and with scalloped margins. Inflorescences coiled to one side distally, taller than the leaves; flowers white or faintly pink. Seeds numerous and minute, 0.5 mm long, pitted and reticulate.

Known from a single record at the boundary of the flora area, which is one of the southernmost records for this species.

Either rare and/or seldom recorded in southwestern Arizona. Often growing in rock crevices; western Arizona and deserts in southern Utah, southern Nevada, and southeastern California.

OP: 100 m N of Organ Pipe and 0.5 km E of Cabeza Prieta NWR, 1700 ft, crevice of rock face, 13 Mar 1993, *Christy 1263* (ASU).

Figure 35. *Phacelia rotundifolia*. (A) Eagle Tail Mts, central-west AZ, photo by John Alcock (SEINet). (B) Table Top Mtn, below SW side of peak, Maricopa Co., 10 Mar 2008, photo by Patrick Alexander (SEINet). (C) Photo by Dave Sussman (SEINet).

Pholistoma

This genus includes three species in California, Arizona, Baja California, and northwestern Sonora.

Pholistoma auritum (Lindley) Lilja var. **arizonicum** (M.E. Jones) Constance
Blue fiesta-flower. Figure 36.

Cool-season ephemerals. Stems square in cross section, brittle and semi-succulent, weak and scrambling through bushes and across rocks. Herbage and calyx with curved hairs that hook onto animals and clothing. Lower leaves opposite, the upper ones alternate; leaves thin, often 3–6 (8) cm long, pinnately lobed. Flowers 1 or few in axillary or terminal cymes. Calyx enlarging in fruit, often ±1.5 cm wide, and with conspicuous auricles often 4–6.5 mm long. Corollas blue. Fruits of globose capsules; seeds 1–4. No other member of the family in the flora area has long, scrambling, weak stems, and clinging, hooked hairs.

Widespread across Organ Pipe, especially in the mountains, and in the eastern part of Cabeza Prieta; washes, upper bajadas, canyons, and rocky slopes, often north-facing and beneath shrubs.

Figure 36. *Pholistoma auritum* var. *arizonicum*. Estes Wash near Bull Pasture Trailhead: (A) 31 Mar 2008; (B) 16 Feb 2005. (C) Alamo Canyon, 26 Feb 2014.

Variety *arizonicum* occurs in western and central Arizona, and northwestern Sonora. Variety *auritum* occurs west of the deserts in California and Baja California.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10817*. Alamo Canyon, 14 Mar 1941, *Benson 10677*. Dripping Springs, 15 Apr 1952, *Parker 7907*. Bull Pasture Trail, 2800 ft, 2 May 1978, *Bowers 1270* (ORPI).
CP: 1.8 mi N of Adobe Windmill, 25 Feb 1993, *Felger 93-62*. Agua Dulce Mts, 26 Feb 1993, *Felger 93-94*. Charlie Bell Road near E Refuge boundary, 9 Apr 1993, *Felger 93-319*. Childs Mountain, 25 Feb 1993, *Felger 93-40*.

Plagiobothrys – Popcorn-flower

Cool-season ephemerals (elsewhere sometimes perennials or bona fide annuals), the herbage pubescent. Leaves basal and cauline, simple, linear to oblanceolate, green, with or without a red-purple midrib and margins. Inflorescences of scorpioid cymes, coiled distally. Flowers small; corollas funnelform to rotate, white or white with a yellow tube and corolla appendages, the limb 1–3 mm wide. Fruits homomorphic, with 2–4 nutlets, the nutlets widely lanceolate to widely ovate, dorsal surface coarsely roughened or tessellate; attachment scar narrowly triangular to linear or ± round, along an elongated ventral keel or at base of a short ventral keel.

The genus is amphitropical in the Americas, mostly in western North America and temperate South America, including 80–90 species; it is not, however, monophyletic.

1. Plants staining red-purple when pressed; fruiting calyx separating around the middle (circumscissile); nutlets 1.5–2.5 mm long, the attachment scar more or less round and at the base of a short ventral keel..... **Plagiobothrys arizonicus**
1. Plants not red-staining; calyx not circumscissile; nutlets 2.5–3 mm long, the attachment scar narrowly triangular to linear along a prominent ventral keel..... **Plagiobothrys jonesii**

Plagiobothrys arizonicus (A. Gray) Greene ex A. Gray
Arizona popcorn-flower. Figure 37.

Plants often 10–40 cm tall. Roots, leaf mid-veins and margins red-purple and staining same color when pressed. Plants with sharp, spreading hairs often with a hard swollen base as well as smaller, softer hairs. Leaves lanceolate to linear-oblanceolate, the larger, lower leaves 3–8 cm long. Calyx body rounded, the lobes free distally; fruiting calyx separating around the middle (circumscissile). Corollas white, sometimes with yellow tube, center, and appendages. Nutlets 2, 1.5–2.5 mm long, broadly ovate, strongly arched or folded in profile, with tubercles along dorsal and lateral ribs, and firmly attached, the attachment scar more or less round and at the base of a short ventral keel.

Sandy loams of plains in the northeastern and north-central part of Organ Pipe. Its history in Organ Pipe extends to 20,500 years.

Southern California to southern Utah, Arizona, northern Sonora, and presumably in northernmost Baja California.

OP: Hwy 85, 1 mi S of N boundary of Monument, *Rutman 2 Apr 1998* (ORPI). Kuakatch Wash near E boundary, 2 Mar 2003, *Rutman 2003-217* (ORPI). Armenta Rd, 1.4 mi W of Hwy 85, 11 Mar 2003, *Felger 03-271*. †Montezuma's Head, nutlets, 13,500 & 20,490 ybp.

Figure 37. *Plagiobothrys arizonicus*. (A) Hwy 86 between road to Kitt Peak and Sells, Pima Co., 19 Mar 2010. (B) Abaxial leaf surface, with bulbous-based hairs and red leaf margin and midvein, Tyrone Ridge Access Road, Grant Co., NM, 10 Mar 2010, photo by Russell Kleinman (gilaflora.com). (C) Sedona, Yavapai Co., 17 April 2001, photo by Max Licher (SEINet).

Plagiobothrys jonesii A. Gray
Mojave popcorn-flower. Figure 38.

Plants (8) 12–45 cm tall, not red-staining; with coarse hairs. Leaves lanceolate to oblanceolate, larger, lower leaves 4–8 cm long, with bulbous-based hairs. Calyx deeply 5-lobed, not circumscissile. Corollas white with a yellow center. Nutlets 3 or 4, ovate-triangular, 2.5–3 mm long, not strongly arched, the attachment scar narrowly triangular to linear along a prominent ventral keel.

Known from several records in the flora area. It is common north and east of the flora area in the Maricopa and Baboquivari Mountains.

Southern California to southwestern Utah, Arizona, and northern Sonora.

This species strongly resembles *Amsinckia* but differs in having a white corolla; Johnston (1923) placed it in *Plagiobothrys* section *Amsinckiopsis* owing to this morphological similarity. Phylogenetic analyses by Matt Guilliams (unpublished data) place this taxon nearer to *Amsinckia* rather than within *Plagiobothrys*, and the appropriate nomenclatural change will be made at a later time.

OP: Twin Peaks, steep S-facing volcanic slope, 1900 ft, *Van Devender 19 Feb 1984.* W side Sierra Santa Rosa, 485 m, upper bajada, 12 Mar 2003, *Felger 03-345.*

Figure 38. *Plagiobothrys jonesii.* (A) Cady Mts, Mojave Desert, San Bernardino Co., CA, 25 Mar 2009, *Sanders 36595* (DES, UCR). (B & F) N end of Red Rock Canyon, Clark Co., NV, 13 Apr 2005, photo by Stan Shebs (SEINet). (C–E) Nutlet, Providence Mts, San Bernardino Co., CA, 24 Apr 1960, *Howe 2875* (SDSU 5441), by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/plagiobothrys/taxa/PL_jonesii/>

Tiquilia

Small, low-growing herbaceous or subshrub perennials, sometimes flowering in first season. Stems with a forked branching pattern (pseudo-dichotomous). Herbage densely and variously hairy. Leaves simple, with revolute (inrolled) margins. Flowers essentially sessile, axillary, single or clustered. Corollas lavender or pinkish. Fruits dry, with 1–4 nutlets.

North and South America in dry regions, mostly deserts; 27 species.

1. Branches alternate; leaf veins obscure and covered by a dense layer of hairs; rocky habitats. ..... **Tiquilia canescens**
1. Branches opposite; leaves with several pairs of conspicuous, impressed veins; sandy habitats.

2. Leaves with 2 or 3 (4) pairs of shallowly impressed veins; nutlets rounded, minutely papillate to dull-surfaced, not smooth and shiny..... **Tiquilia palmeri**
2. Leaves with 5 or 6 (7) pairs of deeply impressed veins, appearing as if pleated; nutlets ovoid, smooth and shiny..... **Tiquilia plicata**

Tiquilia canescens (A. de Candolle) A.T. Richardson
[*Coldenia canescens* de Candolle]
Woody crinklemat. Figure 39.

Figure 39. *Tiquilia canescens*. (A & D) Trail between Twin Peaks Campground and Victoria Mine, OP, 27 Mar 2008. (B) Near Bluebird Mine, Growler Mts, 9 Mar 2014. (C) Page Springs Road by US Hwy 89A, Yavapai Co., 8 Jun 2009, photo by Max Licher (SEINet).

Dwarf, subshrub perennials with short, spreading branches, the stems with spreading hairs. Foliage scruffy gray, the leaves about 1 cm long, ovate to elliptic, with soft, whitish-gray hairs. Flowers pale lavender; with spring and summer-fall rains.

A calciphile on rocky ledges and mesas; Organ Pipe in the Gunsight Hills and Puerto Blanco Mountains and scattered mountains and hills in Cabeza Prieta.

This species occurs in southeastern California to southwestern Utah, New Mexico, and Texas, the Baja California Peninsula, northern Sonora and the Chihuahuan Desert Region in north-central Mexico. Two varieties, distinguished primarily by flower size, are sometimes recognized: var. *canescens* and var. *pulchella* (I.M. Johnston) A.T. Richardson. Both are reported from southwestern Arizona.

OP: 13.5 mi by road NW of Visitor Center, Puerto Blanco Drive, 10 May 1979, *Bowers 1716*. Gunsight Hills, 2 Mar 2003, *Rutman 2003-211*. W end Puerto Blanco Mts, 0.6 mi N of Golden Bell Mine, 14 Mar 2003, *Rutman 2003-315* (ORPI).

CP: Cabeza Prieta Mts, 0.6 mi SW Tule Tank, 1250 ft, *Van Devender 9 Mar 1980*. Scarface Mt, S-facing limestone slope, 1650 ft, *Tallarovic 20 Mar 1992* (ASC). Childs Mt, 2750 ft, 18 Aug 1992, *Felger 92-643A*. Cabeza Prieta Peak, near summit, 24 Mar 1995, *Yeatts 3658* (CAB).

Tiquilia palmeri (A. Gray) A.T. Richardson
[*Coldenia palmeri* A. Gray]
Palmer's crinklemat. Figure 40.

Low-growing, semi-prostrate perennials from very slender roots issuing from even deeper, very thick, long, black roots. Stems very slender, not woody. Petioles prominent, often as long as or longer than the blades; leaf blades 3–8 mm long, broadly elliptic to ovate, rhombic, or nearly orbicular, with conspicuous but shallowly impressed veins on the upper surfaces. Herbage densely pubescent with white hairs and scattered bristles with swollen bases. Flowers lavender-pink with a pale yellow throat; flowering with spring and summer-fall rains. Nutlets 0.8–0.9 mm diameter, 1–4 per fruit, rounded (spheroid).

Sand flats and dunes of the Pinta Sands and near the Butler Mountains.

Southeastern California, southern Nevada, western Arizona, Baja California, and northwestern Sonora.

Seris made a tea from the large, thick root to alleviate stomachache or a cold (Felger & Moser 1985).

CP: Pinacate Plateau, Camino del Diablo, open sandy desert, 28 Oct 1937, *Gentry 3508* (DES). Pinta Sands, 11 Apr 1993, *Felger 93-410*.
TA: Butler Mts, *Van Devender 27 Mar 1983*.

Tiquilia plicata (Torrey) A.T. Richardson
Figure 41.

Plants resembling *T. palmeri* in growth form and habit, but readily distinguished by having more prominent and a larger number of leaf veins. Common on dunes and sandy habitats in the nearby Gran Desierto of Sonora as well as the Mohawk Dunes and near Yuma. It is not known from the flora area although the Pinta Sands near the Sonora border seem like suitable habitat.

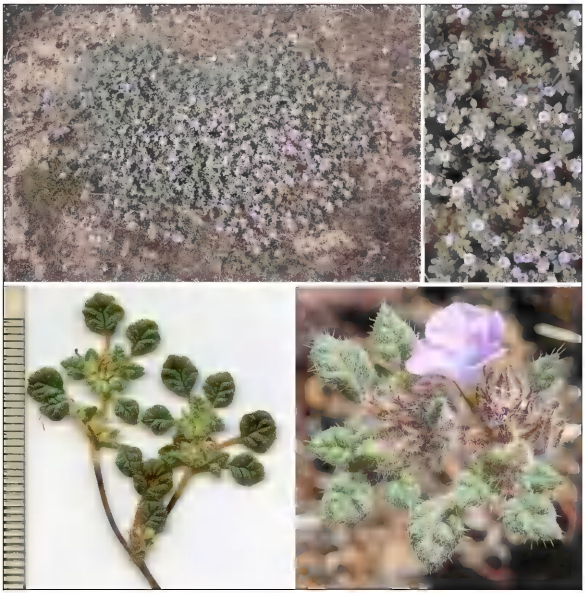

Figure 40. *Tiquilia palmeri*. Cinder plains on road to Red Cone campground, Pinacate Biosphere Reserve, 3 Mar 2009.

Figure 41. *Tiquilia plicata*. (A) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 19 Feb 2005. (B) Sandy wash below Gillespie Dam, Maricopa Co., 31 Mar 2013.

ACKNOWLEDGEMENTS

Supplementing the gratitude expressed in the introduction to our flora (Felger et al. 2013a), we thank George Ferguson, Layla Aerne Hains, Ronald B. Kelley, Andrew C. Sanders, Michael G. Simpson, Thomas R. Van Devender, and George Yatskievych for significant information, assistance, and/or reviews. Susan Davis Carnahan contributed copy-editing expertise.

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 9. EUDICOTS: CONVOLVULACEAE – MORNING GLORY FAMILY

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ABSTRACT

A floristic account is provided for the morning glory family as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the heart of Sonoran Desert in southwestern Arizona. The family includes 11 species in 4 genera (*Cuscuta*, *Evolvulus*, *Ipomoea*, *Jacquemontia*) in the flora area, all of which are native. This is the ninth contribution for this flora published in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium (ARIZ).

The first part of the Flora of southwestern Arizona flora series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a) and explanations for the format for the species accounts is given in part 3 (Felger et al. 2013b). These contributions are also posted open access on the website of the University of Arizona Herbarium (ARIZ). Vernacular, or common names, when known, or deemed worthwhile, are given in English, Spanish, and the Hia C-ed O'odham dialect, respectively. The one fossil specimen is marked with a dagger symbol (†). Area designations are: OP = Organ Pipe Cactus National

Monument, CP = Cabeza Prieta National Wildlife Refuge, and TA = Tinajas Altas (Figure 1). All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2014). All microphotographs of *Cuscuta* are by Mihai Costea and all photos are by Sue Rutman unless otherwise stated. For more images see the galleries provided in the Digital Atlas for the Convolvulaceae of Sonora (Costea & Austin et al. 2012). Descriptions and identification keys pertain to taxa and populations as they occur in the flora area.

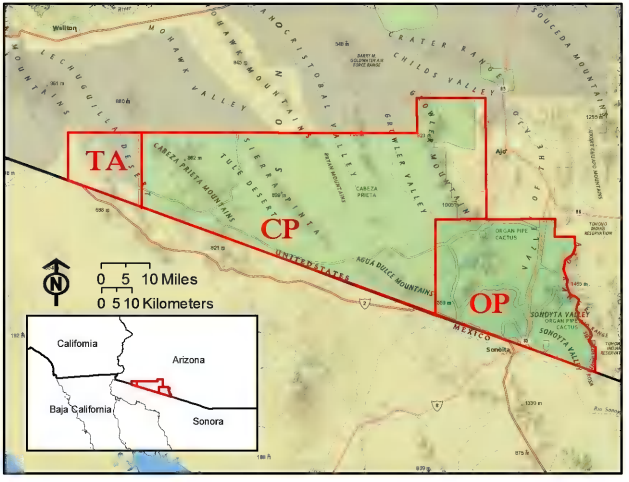

Figure 1. Flora area in southwestern Arizona. Area designations are: OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, and TA = Tinajas Altas. Green shading indicates approximate boundary of federally designated wilderness.

CONVOLVULACEAE – Morning Glory Family

Ephemeral to perennial vines and subshrubs or herbaceous perennials (those in the flora area); or obligate parasites with little or no chlorophyll and vegetative parts much reduced in *Cuscuta*. Leaves alternate, simple, entire to deeply parted, and without stipules. Flowers radial, 5-merous (those in the flora area), and often showy. Calyx persistent. Corollas sympetalous, those in flora area (except *Cuscuta*) with the parts folded within the bud (plicae) being glabrous, whereas those parts exposed in the bud (interplicae) form a star-shaped pattern in the expanded corolla and are often pubescent. Fruits of dry capsules; seeds 1–4 (6).

The Convolvulaceae constitute a diverse cosmopolitan assemblage of 58 genera and an estimated 1880 species (Staples 2014). This monophyletic family has greatest diversity in tropical and subtropical regions worldwide and does not generally occur in higher latitudes, and diversity also

decreases with aridity. Detailed information for the convolvs of Arizona and Sonora is provided by Austin (1998), Costea, Austin, et al. (2012), Costea, Felger, et al. (2012), and Felger and Austin, et al. (2012). Eleven species in four genera occur in the flora area of southwestern Arizona (Table 1). All occur in Organ Pipe, three extend into Cabeza Prieta, and none range into the hyperarid Tinajas Altas Region.

Taxon	Region			Growth Form		
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Ephemeral		Perennial
				Summer	Winter	
CONVOLVULACEAE						
Cuscuta californica var. *californica*	OP			SU		
Cuscuta legitima	OP	CP		SU		
Cuscuta salina	OP			SU		
Cuscuta tuberculata	OP			SU		
Cuscuta umbellata var. *umbellata*	OP	CP		SU		
Evolvulus alsinoides	OP					PR
Ipomoea barbatisepala	OP			SU		
Ipomoea costellata	OP			SU		
Ipomoea cristulata	OP			SU		
Ipomoea hederacea	OP	CP		SU		
†*Ipomoea* sp.	(OP)					
Jacquemontia pringlei	OP					PR
Totals	**11**	**3**	**0**	**9**	**0**	**2**

Table 1. Local distributions and growth forms of Convolvulaceae for the flora in southwestern Arizona. † = Fossil taxon. OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, TA = Tinajas Altas Region.

1. Parasitic twining ephemerals without chlorophyll; stems appearing leafless (leaves reduced to scales) and orange; flowers 5 mm or less in length or width and white..... **Cuscuta**
1. Plants green, not parasitic; stems leafy and not orange; flowers 1 cm or more in width or length and not white (except *Jacquemontia*).

2. Stems not vining; leaves entire, mostly less than 1 cm wide, sessile or very short petioled ..... **Evolvulus**
2. Stems vining; leaves entire or lobed, more than 1 cm wide and petioled.

3. Ephemeral vines; leaves entire, lobed, or divided; corollas various colors but not white; stigmas lobes globose (the stigma is a 2-lobed sphere); pollen grains spiny (visible with a dissecting microscope)..... **Ipomoea**
3. Perennial subshrubs with twining upper stems; leaves entire; corollas white, becoming pale lavender-pink as the flower ages during the day; stigma lobes oblong; pollen grains smooth ..... **Jacquemontia**

Cuscuta – Dodder; *fideo*; vepegĭ vasai

Parasitic twining ephemerals with orange stems, leaves reduced to minute, alternate scales, and small white flowers that become creamy when dried (those in the flora). Flowers 5-merous (those in the flora area; some are 4-merous elsewhere). Growing with warm weather, especially during late spring and the summer rainy season. All the species in the flora area are members of subg. *Grammica* (Costea et al. 2015; García et al. 2014; Stefanović et al. 2007). The two species with

indehiscent (not circumscissile) capsules, *C. californica* and *C. salina*, belong to sect. *Californicae* (Costea et al. 2015; or "clade A", Stefanović et al. 2007); they have somewhat thicker and more robust stems, and parasitize shrubby perennials or herbaceous plants. The species with dehiscent capsules, *C. legitima*, *C. tuberculata*, and *C. umbellata*, belong to sect. *Umbellatae* (Costea et al. 2015; previously called "clade L", Stefanović et al. 2007); they have thinner and more delicate stems, and grow on annuals (ephemerals) and small perennial herbs.

Cuscuta is nearly cosmopolitan and comprises ca. 200 species (Costea 2007; Costea et al. 2015). The taxonomy of this large and diverse genus is complicated (Costea et al. 2015; Stefanović et al. 2007; Yuncker 1932). As in many holoparasitic plants, a number of organs are reduced or absent, and distinguishing features are often minute and not easily seen. Identification during the vegetative stage is possible only by using molecular markers. The minute appendages in *Cuscuta* flowers called infrastaminal scales are taxonomically useful but require the careful dissection of flowers using a microscope, usually at least 50× power. In the flowers of subg. *Grammica*, these minute structures likely have the role to protect the ovary against insect herbivory (Riviere et al. 2013). When viewed fresh and with good illumination the floral structures including the scales are quite beautiful. Yet even dried flowers can be hydrated, dissected, and the floral characters discerned. Upon drying at maturity, the dehiscent (circumscissile) capsules open in a clean circle around the capsule towards the base, while the indehiscent capsules may break apart or rupture irregularly. For more information and images of the floral morphology, see the galleries provided in the Digital Atlas of *Cuscuta* (Costea 2007). Information about pollen, gynoecium, and breeding systems is available in Welsh et al. (2010) and Wright et al. (2011, 2012).

KEY 1. Capsules not needed

1. Perianth, especially the corolla tube papillate; calyx lobes keeled, ⅓–½ as long as the corolla tube; on ephemerals ..... **Cuscuta tuberculata**
1. Perianth not papillate (in *C. umbellata* and *C. salina* papillae or dome-like cells are present only on corolla lobes); calyx lobes not keeled, ¾ as long as the corolla tube, or equaling to longer than corolla tube; on ephemerals or perennials.

2. Infrastaminal scales absent or reduced to ridges; Ajo Mountains, often on *Calliandra eriophylla* ..... **Cuscuta californica** var. **californica**
2. Infrastaminal scales present, well developed.

3. Infrastaminal scales slightly shorter than the corolla tube, oblong; styles shorter than the ovary; locally on *Suaeda* in SW part of Organ Pipe ..... **Cuscuta salina**
3. Infrastaminal scales equaling or exceeding corolla tube, spatulate to obovate; styles equaling or longer than the ovary; widespread on herbaceous perennials (not on *Suaeda*) and especially on summer ephemerals.

4. Flowers 4–5.5 (6) mm long ..... **Cuscuta legitima**
4. Flowers 2–3 mm long ..... **Cuscuta umbellata** var. **umbellata**

KEY 2. Capsules needed

1. Capsules not circumscissile, sometimes breaking apart irregularly.

2. Capsules ± globose, not narrowed apically or thickened around the interstylar aperture; 2–4 seeds per capsule; known from the Ajo and Santa Rosa Mountains, often on *Calliandra eriophylla* ..... **Cuscuta californica** var. **californica**
2. Capsules ellipsoidal, narrowed apically and thickened around the interstylar aperture; 1 seed per capsule (rarely 2); localized on *Suaeda* at Quitobaquito ..... **Cuscuta salina**

1. Capsules circumscissile, opening in a clean circle around the capsule towards the base.

3. Calyx lobes keeled, ⅓–½ as long as the corolla tube; corolla tube cylindrical; infrastaminal scales conspicuously shorter than the corolla tube, not reaching the filaments ..... **C. tuberculata**
3. Calyx lobes not keeled, as long as, or longer than the corolla tube; corolla tube campanulate; corolla scales reaching the filaments and often slightly protruding from the corolla tube.

4. Flowers 4–5.5 (6) mm long ..... **Cuscuta legitima**
4. Flowers 2–3 mm long ..... **Cuscuta umbellata** var. **umbellata**

Cuscuta californica Hooker & Arnott var. **californica**
California dodder. Figure 2.

Inflorescences loose to dense, paniculate; pedicels 0.5–3.0 mm long. Flowers 5-merous, 3–5 (5.5) mm long, fleshy; papillae absent. Calyx 1.5–2.2 mm long, golden yellow when dried, finely reticulate and shiny, turbinate-campanulate, ¾ to as long as the corolla tube, tube 0.4–0.7 mm long, lobes 0.8–2 mm long, triangular-ovate to lanceolate, overlapping at the base, acute to acuminate. Corolla 3–5 mm long, the tube 1.6–2.4 mm long, cylindric-campanulate to obconic, lobes 2.0–2.6 mm long, narrowly lanceolate, equaling or longer than the corolla tube, initially erect, later reflexed. Infrastaminal scales absent or reduced to ridges. Ovary ovoid to obovoid; styles evenly filiform, 1.2–2.2 mm long, as long or longer than the ovary. Capsules 1.5–2.2 × 1.2–2.5 mm, indehiscent, ± globose, not narrowed apically or thickened around the interstylar aperture, surrounded (not capped) by the withered corolla. Seeds 2–4 per capsule. References: Costea et al. (2006); Costea & Stefanović (2009).

Plants in the flora area are var. *californica* characterized by non-papillate flowers and capsules with 2–4 seeds. Often abundant in the Ajo Mountains where it can turn entire slopes orange in April, and visitors to Organ Pipe Cactus National Monument ask about it every year; also in the Santa Rosa Mountains. Often on *Calliandra eriophylla* but also on a wide range of annuals (ephemerals) and perennials.

Washington to Baja California, southern Nevada, and western Arizona. It is unknown from Sonora but is expected in nearby north-central regions of the state.

OP: Cement Tank [Alamo Canyon], [on *Calliandra eriophylla*, flowers 4.5–5.5 mm, calyx shorter than the corolla tube], 14 Apr 1941, *McDougall 97*. Alamo Canyon, 28 Aug 1943, *Clark 10924* (ORPI). Bull Pasture: 3300 ft, 9 May 1979, *Bowers 1712*; abundant on *Calliandra eriophylla* and many other hosts including *Calochortus*, *Cryptantha*, *Verbena neomexicana*, etc, 9 Apr 2005, *Felger 05-178*.

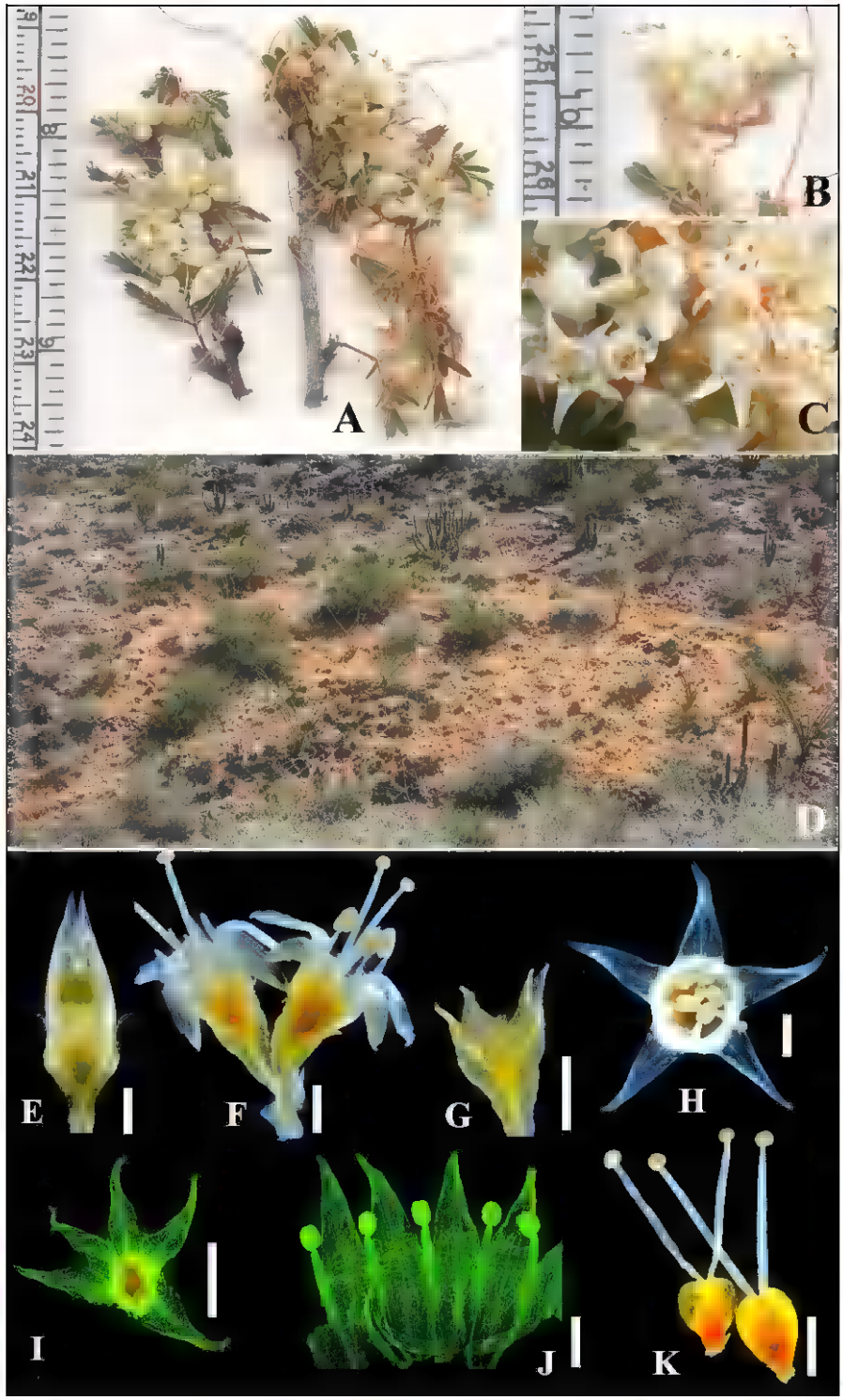

Figure 2. *Cuscuta californica* var. *californica*. Bull Pasture: (A & B) on *Calliandra eriophylla*, 7 Mar 2014; (C) 30 Mar 2008; (D) characteristic expansive local population, 11 May 2010. Flower morphology, scale bars = 1 mm: (E) flower before anthesis; (F) flowers; (G) calyx (not dissected); (H) corolla viewed from the top; (I) dissected calyx; (J) dissected corolla (note the lack of infrastaminal scales); (K) gynoecia.

Cuscuta legitima Costea & Stefanović
[*C. umbellata* var. *reflexa* (J.M. Coulter) Yuncker]
Figure 3.

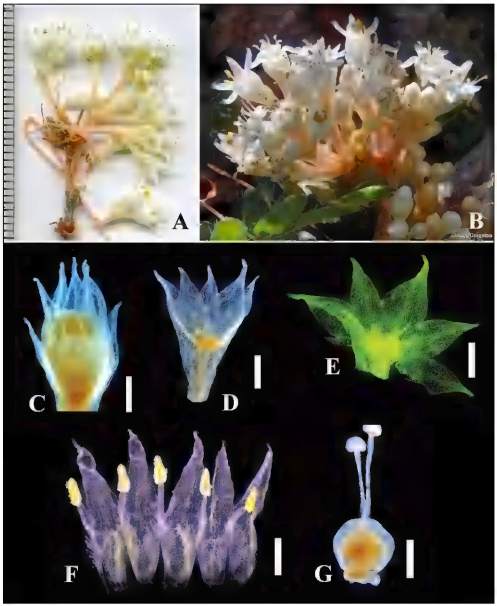

Figure 3. *Cuscuta legitima*. (A) Mex Hwy 8, 35 km S of Sonoyta, 12 Sep 2014. (B) Carlsbad, Eddy Co., NM, 3 Nov 2011, © photo by Terry Gregston (Costea 2007). Flower morphology, scale bars = 1 mm: (C) flower; (D) calyx, not dissected; (E) dissected calyx; (F) dissected corolla; (G) gynoecium.

Inflorescences dense to loose, umbelliform; pedicels 2–10 mm long. Flowers 5-merous, 4–5.5 (6) mm long, membranous; papillae absent. Calyx 2.5–3.2 mm long, straw-yellow, finely reticulate, slightly shiny, campanulate, longer than corolla tube, divided ⅔ the length, the calyx tube 0.6–1 mm long with lobes 1.5–2.2 mm long, not basally overlapping, ovate-lanceolate, not carinate, the apex (calyx lobes) acuminate. Corollas 3.8–5.2 (5.6) mm long, the tube 1.6–2.1 mm long, campanulate, the lobes 1.8–3 mm long, initially erect, later reflexed, longer than the tube, linear-

lanceolate, margins entire, apex acuminate. Infrastaminal scales 1.8–2.2 mm long, equaling or slightly longer than the tube, bridged at 0.2–0.4 mm, spatulate to obovate, fimbriae 0.2–0.5 mm long. Ovary globose; styles 0.9–2.5 mm long, longer than the ovary. Capsules 2–3 × 1–2 mm, circumscissile, depressed, irregularly thickened and slightly elevated around the inconspicuous interstylar aperture, translucent, surrounded or capped by the withered corolla. Seeds 2–4 per capsule.

Cuscuta legitima is a hybrid species and its putative parents are *C. umbellata* var. *umbellata* on the paternal side and *C. odontolepis* (or some other unknown related species) on the maternal side (Costea & Stefanović 2010). This relationship explains the morphological similarity between *C. legitima* and *C. umbellata* var. *umbellata*.

Known from Organ Pipe by a single record and from Cabeza Prieta by two records, but probably more widespread. On herbaceous hosts.

Arizona to Kansas, New Mexico, and Texas, and Mexico in Baja California, Sonora, Chihuahua, Coahuila, and Tamaulipas.

OP: Estes Canyon, in wash, on *Eriogonum deflexum,* 26 Aug 2014, *Rutman 20140826-6.*
CP: 1 mile S of Bates Well Road on road to José Juan Tank at boundary of the Refuge and Organ Pipe, sandy desert plain, on *Boerhavia erecta, B. spicata, Bouteloua aristidoides, B. barbata, Chamaesyce polycarpa, Kallstroemia californica, K. grandiflora, Tidestromia lanuginosa*, 15 Sep 1992, *Felger 92-740* (ARIZ, CAS). Daniels Arroyo at Charlie Bell Road, on on *Kallstroemia* sp. and *Tidestromia lanuginosa*, 24 Aug 2014, *Rutman 20140824-6.*

Cuscuta salina Engelmann
Saltmarsh dodder. Figure 4.

Inflorescences dense, corymbiform; pedicels (0.5) 1–5 mm long. Flowers 5-merous, 2.5–4.5 mm long, fleshy, papillae or dome-like cells present on the corolla lobes. Calyx 1.5–2.5 mm long, glossy yellow, cylindric to narrow campanulate, equaling corolla tube, tube 0.6–1.2 mm long, lobes 0.7–1.5 mm long, ovate-lanceolate to lanceolate, not basally overlapping, acute to acuminate. Corolla 2.2–4.0 mm long, the tube 1.2–2 mm long, cylindric-campanulate to obconical, the lobes 1.3–2 mm long, ovate-lanceolate to oblong-lanceolate, equaling the corolla tube, initially erect, later spreading or reflexed, apex acute to acuminate or cuspidate (sometimes appearing tridentate). Infrastaminal scales 1–1.8 mm long, 80–90% of the corolla tube length, oblong to slightly obovate, bridged at 0.18–0.45 mm, fimbriae 0.03–0.20 mm long. Ovary ellipsoid, the styles 0.4–0.9 mm long, shorter than the ovary. Capsules 1.6–2.5 × 1.7–2.2 mm, indehiscent or irregularly dehiscent, ellipsoid, narrowed at the top and thickened around the small interstylar aperture, surrounded or capped by the withered corolla. Seeds 1 (2) per capsule. References: Costea et al. (2006, 2009).

Reproductive June–December. Localized along the southwest boundary of Organ Pipe from the vicinity of Quitobaquito to Hocker Well and in adjacent Sonora near Sonoyta, growing on *Suaeda nigra* [*S. moquinii*].

Cuscuta salina occurs in Baja California, New Mexico, Texas, Utah, and southern Arizona where the populations apparently are few and widely disjunct and in adjacent northern Sonora. Host plants are *Frankenia, Salsola, Suaeda,* and *Wislizenia*.

OP: Hocker Well, 20 Dec 2001, *Rutman s.n.* (ORPI). Quitobaquito: [on *Suaeda nigra*] 29 Nov 1939, *Harbison 26193*; 8 Oct 1960, *Hevly s.n.*; On *Suaeda moquinii* in *Suaeda* flats, 17 May 1982, *Nabhan s.n.*; Several large colonies on *Suaeda moquinii*, 19 Jun 1989, *Felger 89-241* (ARIZ, ASU).

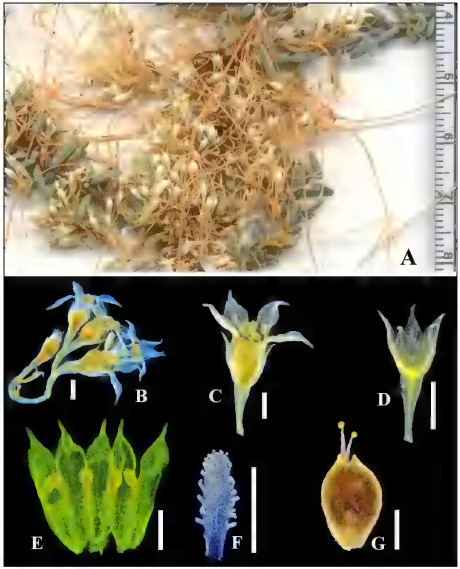

Figure 4. *Cuscuta salina*. (A) On *Suaeda nigra*, Quitobaquito, 11 Sep 2008. Flower morphology, scale bars = 1 mm: (B) fragment of inflorescence; (C) flower; (D) calyx, not dissected; (E) dissected corolla; (F) infrastaminal scale removed from the flower; (G) gynoecium.

Cuscuta tuberculata Brandegee
Desert dodder. Figure 5.

Inflorescences loose, umbelliform or racemiform; pedicels 2–3 (5) mm long. Flowers 5-merous, 2.5–4 mm long, membranous; papillae present especially at the base of the corolla tube. Calyx 0.5–1.5 mm long, yellow, finely reticulate or not, ± glossy, campanulate-angular, ⅓–½ as long as the corolla tube, the calyx tube 0.2–0.5 mm long, the lobes 1–1.3 mm long, not basally overlapping, triangular to lanceolate, carinate and with multicellular protuberances, acute to acuminate. Corollas 2–3.5 mm long, the tube 1.5–2.2 mm long and cylindrical, the lobes 1.2–2 mm long, ½ the length of the corolla tube, bridged at 0.3–0.5 mm, ovate, uniformly short-fringed, fimbriae 0.05–0.15 mm long. Ovary globose; styles 1.5–3 mm long, longer than the ovary, and evenly filiform. Capsules 1.3–2.2 × 1–2.3 mm, circumscissile, globose, slightly thickened and risen around the small interstylar aperture, translucent, capped by the withered corolla. Seeds usually 4 per capsule. Facultative xenogamous (Wright et al. 2012). Reference: Costea & Stefanović (2010).

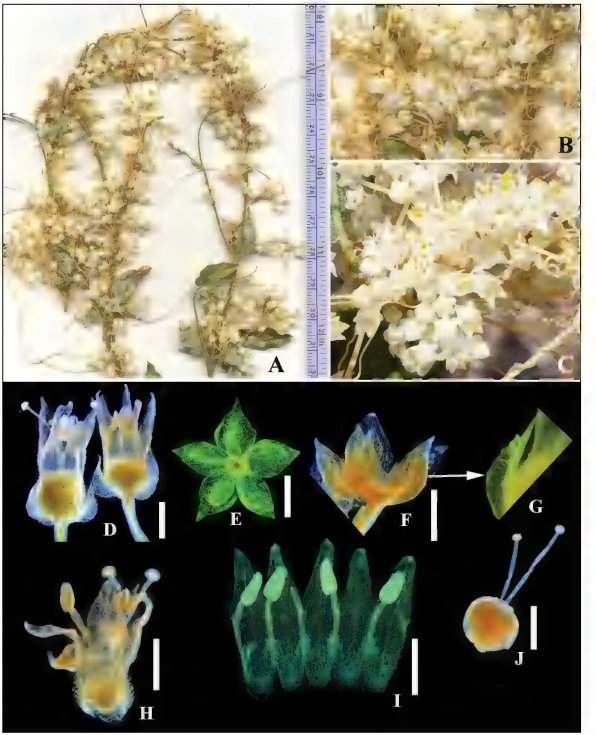

Figure 5. Cuscuta tuberculata. (A & B) On Boerhavia, Alamo Canyon, 7 Sep 2013. (C) Gunsight Hills near E boundary of Organ Pipe, 10 Sep 2013. Flower morphology, scale bars = 1 mm: (D) flowers; (E) dissected calyx; (F) calyx, not dissected; (G) detail of calyx lobe carena (carinate keel); (H) corolla (note the papillae on the corolla tube); (I) dissected corolla; (J) gynoecium.

Widespread in lowland desert areas and extending into mountains in Organ Pipe; on summer ephemerals, especially *Boerhavia* spp. and *Pectis papposa*.

Southwest and south-central Arizona, New Mexico, northern Mexico including Baja California Sur and western Sonora southward at least to the vicinity of Hermosillo.

OP: 16.3 mi by road N of Lukeville, disturbed area, low rocky hills, mostly on *Boerhavia coulteri*, 26 Sep 1964, *Felger 10532*. Bull Pasture, on *Boerhavia*, 5 Nov 1977, *Bowers 949*. N end Cipriano Hills, on *Boerhavia*, 18 Sep 1988, *Wirt s.n.* Basalt flat near W-facing slopes of Santa Rosa Mts, on *Boerhavia spicata*, 29 Aug 2001, *Rutman s.n.*

Cuscuta umbellata Kunth var. **umbellata**
Figure 6.

Inflorescences dense to loose, umbelliform; pedicels 2–10 mm long. Flowers 5-merous, 2–3 mm long, membranous; papillae sometimes present but only on the adaxial face of corolla lobes. Calyx 0.8–1.4 mm long, straw-yellow, finely reticulate, slightly shiny, campanulate, equaling the corolla tube, the tube 0.25–0.6 mm long, the lobes 0.5–0.9 mm long, not basally overlapping, broadly triangular-ovate, not carinate, the margins entire, the apex obtuse to acute. Corollas 2–2.5 mm long, the tube 0.6–1.2 mm long, campanulate, the lobes 0.8–1.5 mm long, initially erect, later reflexed, equaling or slightly longer than the tube, oblong to lanceolate, the apex obtuse to acute. Infrastaminal scales 0.8–1.2 mm long, equaling or slightly longer than the corolla tube, bridged at 0.1 mm, subspathulate to obovate, uniformly dense-fringed, the fimbriae 0.15–0.32 mm long. Ovary globose; styles 0.8–1.7 mm, equaling or longer than the ovary, evenly filiform. Capsules circumscissile, 1–2.5 × 0.5–1.2 mm, depressed, irregularly thickened and slightly risen around the inconspicuous interstylar aperture, translucent, surrounded or capped by the withered corolla. Seeds 4 per capsule. Facultative xenogamous to facultative autogamous (Wright et al. 2011). Reference: Costea & Stefanović (2010).

Lowlands scattered across the flora area, especially areas of dense growth of ephemerals such as washes, floodplains, and sand flats. Parasitic on a wide range of small perennial herbs and spring and summer ephemerals including *Allionia, Boerhavia, Bouteloua, Bromus, Daucus, Euphorbia* (*Chamaesyce*), *Kallstroemia, Dinebra* (*Leptochloa panicea*), *Pectis*, *Plantago*, *Senecio, Silene, Tidestromia*, and *Trianthema*.

Arizona, Colorado, New Mexico, and Texas to South America and the West Indies.

OP: Alamo Canyon, on *Boerhavia*, 28 Aug 1943, *Clark 10924* (ORPI). Armenta Well, on *Allionia*, 1600 ft, 16 Nov 1974, *Warren s.n.* (ORPI). Aguajita, on *Bouteloua barbata, Leptochloa panicea, Trianthema portulacastrum, Tidestromia lanuginosa*, 14 Sep 1988, *Felger 88-414*. Just N of U.S./Mexico boundary E of Lukeville, 3 mi E of Dos Lomitas, on *Tidestromia*, 29 Aug 2001, *Rutman s.n.*. Growler Wash floodplain near Bates Well Ranch, 23 Aug 2001; *Rutman s.n.*. W braid of Cuerda de Leña, on *Allionia incarnata*, *7 Oct 2006, Rutman 20061007-8*.

CP: 5 km N of Pinta Sands, [on *Pectis papposa*], 2 Oct 1964, *Simmons s.n.* 1.1 mi S of Bates Well Road on road to Jose Juan Tank, at E Refuge boundary, on *Kallstroemia, Boerhavia, Allionia*, 14 Sep 1992, *Felger 92-707*. Daniel's Arroyo, on *Allionia*, 27 Sep 1992, *Harlan 329*. San Cristobal Wash, on *E. polycarpa, E. albomarginata*, 14 Sep 1992, *Felger 92-687B*. 1 mi S of Bates Well Road on road to Jose Juan Tank, at E Refuge boundary, on *Allionia, Boerhavia erecta, B. spicata, Bouteloua aristidoides, Kallstroemia californica, K. grandiflora, Tidestromia lanuginosa*, 15 Sep 1992, *Felger 92-740*.

Evolvulus

Annuals or perennials, stems not twining. Styles 2, bifid, the 4 stigmas long and thread-like. Native to the New World; about 100 species. Four species occur in Arizona (Austin 1988) and 7 species occur in Sonora (Felger & Austin et al. 2012).

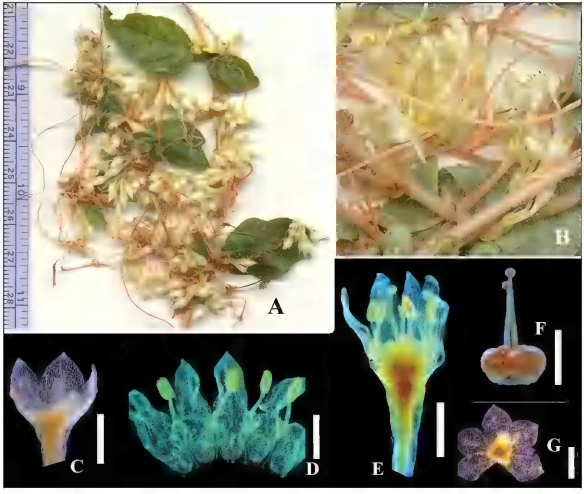

Figure 6. *Cuscuta umbellata* var. *umbellata*. (A) On *Boerhavia*, San Cristobal Wash near Camino del Diablo, 26 Sep 2013. (B) On *Boerhavia*, near Cuerda de Leña and N boundary of Organ Pipe, 30 Sep 2006. Flower morphology scale bars = 1 mm: (C) calyx (not dissected); (D) dissected corolla; (E) flower; (F) gynoecium; (G) dissected calyx.

Evolvulus alsinoides Linnaeus

[*E. alsinoides* var. *acapulcensis* (Willdenow) van Ooststroom. *E. alsinoides* var. *angustifolia* Torrey] Mouse ears; *oreja de ratón*. Figure 7.

Small tufted perennials, the herbage densely pubescent with appressed and long spreading hairs. Stems very slender and wiry, usually less than 25 cm long, dying back to near ground level in drought. Leaves 7–23 mm long, lance-linear to elliptic, smaller above, sessile or very short petioled. Pedicels slender, 3–6 mm long; calyx 2–2.5 mm long. Corollas 8–10 mm wide, rotate, pale blue with a white center, glabrate except the prominent star-like interplicae. Ovary, style, and anthers pure white, the filaments pale blue. Flowering at various seasons; flowers diurnal—opening in mid-morning and closing in the afternoon. Capsules globose, 2.5–3 mm diameter, 1–4-seeded. Flowering in warmer months with sufficient moisture.

Widely scattered in Organ Pipe in washes, canyons, and on rocky slopes.

Figure 7. *Evolvulus alsinoides*. (A) Estes Canyon, 21 Sep 2008. (B) Salero Ranch, 8 mi ESE of Tubac, Santa Cruz Co., 19 Feb 2014, photo by Sue Carnahan. (C) Alamo Canyon, 9 Sep 2013. (D) Owl Canyon, Florida Mts, Luna Co., NM, 25 Aug 2008, photo by Patrick Alexander.

Native from Arizona to South America, and now a pantropical weed. This species is extremely polymorphic. Van Ooststroom (1934) recognized fifteen varieties around the world, although the variation is often not well defined. Sonora, Arizona, New Mexico, and Texas plants belong to var. *angustifolia* Torrey. This variety typically has shorter sepals, narrower leaves, and less densely pubescent stems, and tends to have shorter stems than other varieties, if indeed the variety is worthy of recognition. At least a few populations in Asia and Australia appear to have differentiated

since post-Columbian times into potentially new infraspecific taxa, in a manner akin to the English sparrow in North America.

OP: Alamo Canyon, *Nichol 26 Mar 1938*. Sonoyta Hills, 27 Aug 1943, *Clark 10885* (ORPI). 2 mi due W of Sweetwater Pass and 0.5 mi SE of Interpretive Marker 18, 31°59'20"N, 112°4'55"W, 630 m, E-facing hillside, to 20 cm tall, growing from the bases of shrubs and through them, local but abundant, flowers lavender-blue, *Ambrosia deltoidea, Cereus giganteus, Calliandra, Coursetia, Simmondsia, Bursera microphylla, Opuntia acanthocarpa*, 1 Mar 1989, *Baker 7710* (ASU). Bull Pasture, 9 Apr 2003, *Felger* (observation).

Ipomoea – Morning Glory; *trompillo*

The three morning glories in the flora area are ephemeral vines growing with hot-weather rains. Leaf characters in the key refer to the upper or mid-stem leaves. Fruit a several-seeded capsule.

Worldwide, most diverse in tropical and subtropical regions; perhaps 600 species. Arizona has 13 species (Austin 1998) and Sonora has 41 species (Felger & Austin et al. 2012).

1. Leaves pedately dissected into 5–9 linear or linear-lanceolate segments …..... **Ipomoea costellata**
1. Leaves entire or shallowly to deeply 3–5 lobed, the lobes broad (not linear or linear-lanceolate) and not pedately arranged.

2. Corollas red-orange; sepals glabrous …….. **Ipomoea cristulata**
2. Corollas blue; sepals with coarse hairs.

3. Lower leaf surfaces usually with glandular dots; sepals 10–12 mm long; sepal bases and pedicels glabrous …….. **Ipomoea barbatisepala**
3. Lower leaf surfaces without glandular dots; sepals 12–24 mm long; sepal bases and pedicels pubescent …….. **Ipomoea hederacea**

Ipomoea barbatisepala A. Gray
Figure 8.

Vines, the stems low-climbing, glabrous. Leaves glabrous, often with glandular dots at least on the lower surfaces, deeply 5–7 lobed, the lobes lanceolate and narrowed toward base, acute to acuminate. Sepals 10–12 mm long, 1–2 mm wide, the bases slightly dilated, hispid-pilose throughout, the apex elongate narrowly linear, typically erect to spreading. Corollas 1.6–2 (2.5) cm long, blue-purple with a white throat. Capsules glabrous.

In the flora area known from ephemeral watercourses in Bull Pasture and probably along other drainages in the higher elevations of the Ajo Mountains. The nearest known population is in the Baboquivari Mountains; it extends into the margins of the Sonoran Desert but not into the drier, lower desert elevations.

Arizona, New Mexico, Texas; Baja California Sur, Sonora, Sinaloa, and disjunct to Oaxaca.

In many ways this species resembles *Ipomoea hederacea*, which may grow with it, but *I. barbatisepala* is more delicate, the leaf lobes are narrower, acuminate, and deeply cut, and the corollas are typically smaller. The hirsute pubescence going the length of the sepals and the deeply lobed leaves are diagnostic.

OP: Bull Pasture, 19 Sep 2014, *Rutman 20140919-7*.

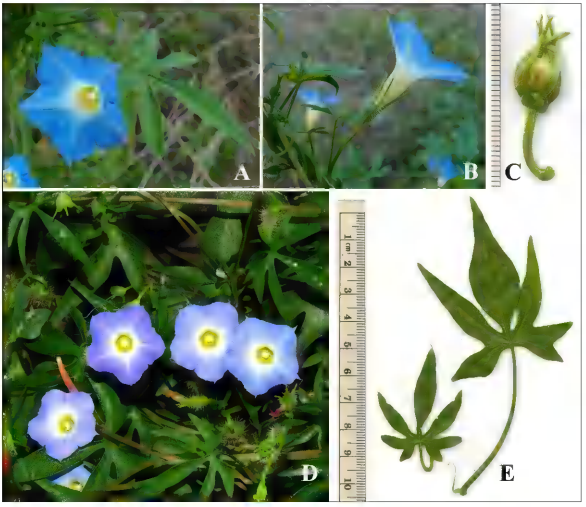

Figure 8. *Ipomoea barbatisepala*. (A & B) Salero Ranch, Santa Cruz Co., 28 Aug 2013, photos by Sue Carnahan (SEINet). (C & E) Bull Pasture stream, 19 Sep 2014. (D) Brown Canyon, Baboquivari Mts, 5 Sep 2009, photo by Dan Austin.

Ipomoea costellata Torrey
Crest-rib morning glory. Figure 9.

Stems trailing or twining. Leaves pedately dissected into 5–9 linear or linear-lanceolate segments. Sepals conspicuously crested and warty. Corollas 10–12 mm long, 5–10 (14) mm wide, pale lavender to pink.

In the flora area known only from the Ajo Mountains; it is common in Bull Pasture.

Eastward in Arizona to west Texas, most of Mexico including Baja California Sur, and Guatemala.

OP: Bull Pasture, 12 Aug 1990, *Wirt s.n.* (ORPI). Saddle between Arch Canyon and Boulder canyons, 26 Oct 2003, *Rutman 20031026-17* (ORPI). Bull Pasture area, 3170 ft, temporally wet or moist drainage on bedrock, cryptic annual growing amid dense summer growth [including] *Evolvulus*, *Ipomoea hederacea*, *I. cristulata*, etc., 25 Sep 2013, *Rutman 20130925-5*.

Figure 9. *Ipomoea costellata.* Bull Pasture, seasonally wet stream below the spring, 25 Sep 2013.

Ipomoea cristulata Hallier f.
[*I. coccinea* of authors, not Linnaeus. *Quamoclit gracilis* Hallier f.]
Scarlet morning glory. Figure 10.

Delicate to moderately robust but small vines. Leaves variable, with a cordate base, otherwise entire or shallowly to broadly 3 (5) lobed. Calyx glabrous, the lobes linear-subulate. Corollas 1–1.5 cm wide, trumpet-shaped (salviform), bright red-orange. Flowers diurnal and pollinated by butterflies and hummingbirds, however, apparently also capable of selfing (facultatively autogamous).

In the flora area known from the Ajo and Diablo Mountains.

Midwestern United States (where presumably cultivated) to Arizona and Texas, and Mexico south to Veracruz and in Baja California Sur.

OP: Alamo Canyon, 13 Dec 1939, *Harbison 26244* (SD). Arch Canyon, *Wirt 13 Oct 1990.* S fork of Alamo Canyon, 2400 ft, abundant in wash bed and xeroriparian area, 7 Sep 2013, *Rutman 20130907-1*. Diablo Mts, 2647 ft, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-13*.

Figure 10. *Ipomoea cristulata*. Alamo Canyon: (A & D) 7 Sep 2013; (B) 9 Sep 2013; (C) 17 Oct 2013. (E) By Lucretia Brezeale Hamilton.

Ipomoea hederacea Jacquin
Ivy-leaf morning glory. Figure 11.

Vines; often robust and covering shrubs and small trees, often twining 2–3+ m in mesquites; densely to sparsely hairy throughout. Leaf blades (2) 3.5–13 (15.5) cm long and about as wide, 3-lobed to 3- or 5-parted. Calyces 15–25 mm long, the lobes lanceolate, narrowed above the base, the expanded, basal portion with long spreading hairs. Corollas opening wide, often 3–3.5 cm wide, light blue with a white base, open in the early morning and visited by white-lined sphinx moths (*Hyles lineata*) and butterflies, and closing with mid-morning heat. Capsules 9 mm wide. Seeds 4.5–4.8 mm long, dark brown to blackish, wedge-shaped, with minute hairs.

Often locally abundant following summer rains, growing through mesquites and other shrubs along large washes and canyon bottoms. Ajo Mountains and the northern part of Organ Pipe, and

especially the larger, brushy washes such as the San Cristobal and Growler Wash systems in the eastern part of Cabeza Prieta where it often festoons mesquites in green curtains (Felger 2007).

Figure 11. *Ipomoea hederacea*. (A) Armenta Ranch, 12 Sep 2008. Alamo Canyon: (B) 7 Sep 2013; (D) 9 Sep 2013. (C) Catalina Mts, Pima Co, Sep 1989, photo by Dan Austin. (E) Climbing on *Prosopis velutina*, wildlife tank near N boundary of Organ Pipe, E of Hwy 85, 20 Sep 2013.

Temperate North and South America; introduced in the Old World and also likely introduced into South America.

OP: Alamo Canyon, 28 Aug 1943, *Clark 10939* (ORPI). Bull Pasture Trail, 11 Sep 1988, *Wilson 189*. Road to Armenta Ranch, 1 Feb 2002, *Felger* (observation, dry, dead plants).

CP: Monreal Well, *Monson 19 Sep 1959*. San Cristobal Wash: 14 Sep 1992, *Felger 92-693*.

†Ipomoea sp.
OP: †Alamo Canyon, fruit, 1150 ybp.

Jacquemontia

Perennials or occasionally annuals; 80–100 species in the Americas and several in Australia. Four species in Arizona (Austin 1988) and five in Sonora (Felger & Austin et al. 2012).

Jacquemontia pringlei A. Gray
Desert cluster-vine. Figure 12.

Perennials; scandent or sprawling subshrubs, with 4–6 rayed stellate hairs, the upper stems often twining, growing and flowering during the warmer months. Leaves 2–6 cm long, petioled, the blades ovate with entire margins. Inflorescences of axillary cymes with 1–7 flowers. Outer sepals broadly ovate, the inner sepals narrower. Corollas about 2 cm wide, white, becoming pale lavender as the flower ages during the day.

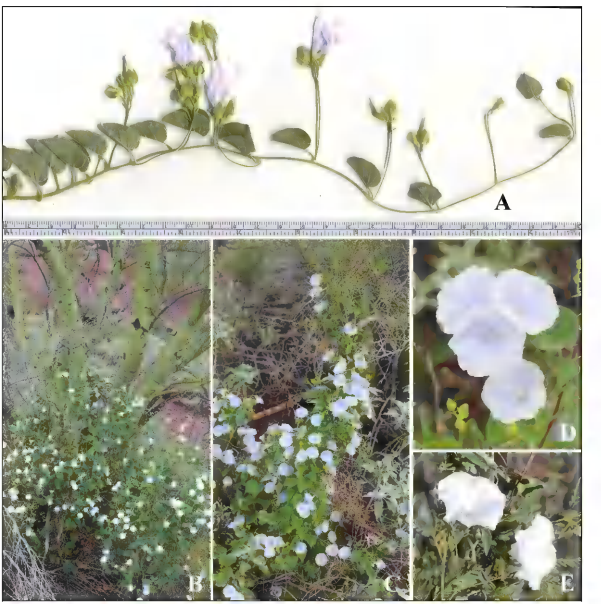

Figure 12. *Jacquemontia pringlei*. Alamo Canyon, south-facing slope: (A & E) 10 Sep 2008; (B) 7 Sep 2008; (C & D) 7 Sep 2013.

In the flora area known from the Ajo Mountains, at least in Alamo Canyon. This is the most arid and farthest western locality verified for the genus.

This species ranges from southern Arizona to northwestern Sinaloa and southwestern Chihuahua; it is widespread through Sonora except the northwestern corner of the state. This genus has its greatest diversity in tropical and subtropical Latin America. An enigmatic specimen collected by A.A. Nichol on 25 April 1938 at the "South end of Gila Mountains" seems out of place and the locality questionable. Before the mid-20th century it was customary to include the Tinajas Altas Mountains in the concept of the Gila Mountains. On that same day Nichol collected *Muhlenbergia dumosa* in the "Mohawk Mountains" and *Aristida purpurea* in the "Gila Mountains" (specimens at ARIZ). There are no other records for *Jacquemontia* or *Muhlenbergia dumosa* in Yuma County (Felger & Van Devender et al. 2012; SEINet 2014). Richard has looked for them in possible habitats in the Gila-Tinajas Altas Mountains.

OP: Ajo Mts, 21 Nov 1934, *Goodding 227*. Alamo Canyon: 28 Aug 1943, *Clark 10945* (ORPI); *Van Devender 31 Aug 1978* (ORPI). Ajo Mts, mouth of Alamo Canyon, 2200 ft, 7 Sep 1947, *Fouts 198* (NMC).

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MIKANIA PARVIFLORA (ASTERACEAE: EUPATORIEAE) AND NEAR RELATIVES

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ABSTRACT

The *Mikania parviflora* complex consists of 17 species characterized by rather large, sessile, ternately disposed capitula and hirsute style appendages and bases. The group is distributed from central Mexico southward through Central America to the southern edge of the Amazon Basin of South America. One species is endemic to Cuba, while another occurs in the Lesser Antilles. A key to species, full descriptions and synonymy, distribution statements, citation of selected specimens, discussion, illustrations of leaves, flower, and heads of each species, and six distribution maps are included.

With few exceptions, in the first 100 years after the genus was proposed by Willdenow in 1803, most publications concerning *Mikania* have been descriptions of new species. From about 1900, while proliferation of new species proposals continued, greater emphasis was placed upon the production of floras for various political and/or geographical areas. These works provided the framework for a basic understanding of the genus that is now known to consist of well over 400 species (Holmes 1995; King & Robinson 1987).

The initial attempts at providing a classification of *Mikania*, the works of de Candolle (1836), Baker (1876), and Robinson and Greenman (1896), have been largely artificial and designed primarily to facilitate identification (Holmes 1996). The cited de Candolle and Baker works also added about 150 names to the genus. More recent attempts at delineating a natural order in *Mikania* were those of Robinson (1922a) and Barroso (1958), both patently artificial, and, in my view, far too superficial to reflect the evolutionary trends apparent in the genus.

Much greater insight into the nature of the genus was expressed by Robinson (1922b, 1934) by his recognition of several difficult groups of closely related species. Included here were the *Mikania scandens* (L.) Willd., *M. globosa* (J. Coult.) J. Coult., and *M. parviflora* (Aubl.) Karst. groups, the latter being arguably the best defined and most easily recognized. Robinson (1922b) described the *M. parviflora* affinity as "a very difficult group of closely related plants with rather large closely sessile ternately disposed heads." He included nine species in his key, but *M. brachiata* Poeppig and Endl. (= *M. guaco* Humb. & Bonpl.) and *M. loretensis* B.L. Rob. (= *M. parviflora* are missing. Both are mentioned in the accompanying work in the same volume (Robinson 1922a) as having capitula "clustered in 3's and 5's at the tips of the ultimate branchlets of the corymbs" and were known to exhibit all characteristics of the group. Their absence appears based upon size of the capitula, which were considered "middle-sized" by Robinson.

Though not afforded official status or mentioned under this name by Robinson (1922b), the name *Mikania parviflora* is used here because it is nomenclaturally the oldest and was used by Robinson as a means of introducing the species group. The group, sometimes referred to as the *M. guaco* group after the most commonly collected, widely distributed, and best known member, is mentioned in various papers discussing clarifications of synonymy and proposals of new species with presumed affinity to the group (e.g., Holmes 1995, 1996; Holmes & McDaniel 1979; King & Robinson 1985, 1987; Pruski 1991).

The purpose of the paper is to provide a taxonomic treatment for one of the best defined species complexes of the genus. This includes a precise description of the group, comments on the origin of the ternate, sessile-capitula condition, discussion of the relationship of members of the group to themselves and to *Mikania* species not in the group, and an explanation of mophological trends evident within the group. The work is based upon study of the extensive *Mikania* holdings in US, though consultation of several type specimens from other herbaria was necessary. These are duly acknowledged and cited within the text in the appropriate places. Visits to G-DC and P conducted over the past several years permitted study of important specimens not otherwise available.

While it is clear that the *Mikania parviflora* group will ultimately be assigned official nomenclatural status, it is inappropriate to do so at this time because of uncertainty as to what taxonomic rank it should be recognized. That must be postponed until *Mikania* as a whole is better understood.

Characteristics of the *Mikania parviflora* group

The basic characteristics of the group include the following: corymbiform capitulescences, capitula disposed in sessile (or shortly pedunculate) ternate clusters, hirsute style appendages and bases, and non-cordate leaf bases. Each will be discussed in turn, first describing the condition, then commenting on origin and relationships. Also included are comments of a more general nature that are important for a better understanding of *Mikania*, hence the group under study.

All members of the group have corymbiform capitulescences thus belong to sec. *Mikania* Willd. sensu Holmes (1996). The capitula are disposed in ternate, sessile (or very shortly pedunculate) clusters with each of the two lateral capitula (of a cluster of three) oriented at an angle of about 30° from the main axis of the medial capitulum. [Rarely is there an additional pair of capitula borne below this cluster.] Occasionally all three capitula are pedunculate, but if so, the peduncles of the lateral (outer) capitula are longer than those of the medial (center) capitulum. More commonly, if capitula are pedunculate, it is the lateral capitula that are pedunculate, while the median one is sessile. The peduncle supporting the cluster of capitula is flattened in the same plane as the lateral capitula are disposed (side-to-side). This shows affinity to the pedunculate capitulated corymbiform group such as *M. scandens* (L.) Willd., *M. cordifolia* (L.f.) Willd., etc., which have a similar structural arrangement (Holmes 1996). The *M. parviflora* group appears derived from that group through reduction or loss of the peduncles of each capitulum. An alternative explanation for the origin of the sessile ternate capitula is that the terminal floral meristem splits/divides into three meristems, thus generating three capitula. This, however, ignores the obvious similarity between the two types of capitulescences described above.

There are a number of other *Mikania* of northwestern South America with ternate sessile capitula (e.g., *M. stuebelii* Hieron., *M. laurifolia* Willd., *M. clematidiflora* B.L. Rob., etc.) that seem to form their own group but are not considered closely related to the group under study. The lateral capitula of these species are disposed at right angles to the medial capitulum and are further distinguished by their spiciform-thyrsoid capitulescences and lack of hirsute style appendages and bases.

Capitulum size is 8–12 (14) mm, which, according to Robinson (1922b) would be medium to large. In the genus, capitula vary in length from about 3 mm (*M. minima* B.L. Rob. of Argentina) to 17-18 mm long (*M. chimborazensis* Hieron. of the cordilleras of Ecuador and Peru).

The capitulum of *Mikania* consists of four florets, four phyllaries, and a subinvolucral bract (sometimes called an exterior bract). The phyllaries are arranged into an inner pair and an outer pair, with both margins of each outer phyllary slightly imbricated over the adjacent inner phyllaries. The

abaxial surfaces of the outer pair of phyllaries tend to be more pubescent than those of the inner pair, which are generally glabrate. The apices are generally pubescent in both the inner and outer phyllaries. The outer phyllaries of a cluster of three capitula are orientated in the same plane as is the flattened surface of the peduncle supporting the cluster (see any included species illustration). The inner phyllaries are oriented 90° to this plane, thus, in a cluster of three capitula, the inner phyllaries of the lateral capitula occupy both the adaxial and abaxial positions while the outer phyllaries occupy more lateral positions. The phyllaries of the medial capitulum have an arrangement parallel to that of the lateral capitula, but because they are located on the primary axis, the inner phyllaries are adaxial and the outer abaxial. The subinvolucral bracts of the lateral capitula are located at the very base of the abaxial (outermost) phyllary (there is no place for them in the adaxial position because of the position of the medial capitulum). Subinvolucral bracts of the medial capitula are borne opposite to the outer phyllary that is more distant from the central axis of the capitulescence or more distal from the center ternate cluster as described below (again there is no room opposite the inner phyllaries because the lateral capitula occupy those positions). The subinvolucral bracts of the medial capitula vary in placement, depending on the species, from the uppermost part of the peduncle, where the three capitula are borne (= at the base of the phyllaries), to anywhere from the base of the phyllaries to the very base of the peduncle that supports a cluster of three capitula. Since the capitulescence branches trichotomously, the ternate clusters occur in threes, the center cluster being accompanied by two outer "sister" clusters, which are oriented 90° to the center cluster. This pattern is repeated throughout the capitulescence. There are certain other *Mikania*, such as *M. hexagonocaulis* W.C. Holmes & McDaniel, *M. stygia* B.L. Rob., *M. steyermarkii* King & Rob., and *M. chaetoloba* Pruski with a similar arrangement of capitula and subinvolucral bracts, but these can be distinguished from the *M. parviflora* affinity by the absolute lack of hirsute style appendages and bases, thus they are not considered part of the group.

Phyllaries are normally oblong to elliptic-ovate but otherwise bear no particular distinguishing features/characteristics, except for *Mikania iserniana*, which has very wide phyllaries (ca. 3 mm) for their length. Phyllaries of the other members of the group are 2 mm or less wide.

Based upon spread of the throat and the amount of cutting of the corolla teeth into the throat, the corollas of the *Mikania parviflora* group are of three types. [Illustrations of corolla teeth are in individual species treatments.]

a. Tubular to cylindric corollas, generally with a long corolla throat compared to the tube length and deltate teeth usually less than one-fourth the length of the throat. This is typical of *Mikania parviflora*, *M. neei*, and *M. guaco*. *Mikania dictyophylla* and *M. tafallana* both have this type of corolla, but with slightly longer corolla teeth.

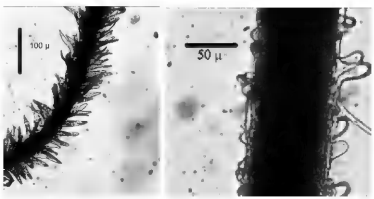
b. Funnelform to narrowly campanulate corollas with the teeth being about the same length as the length of the throat. This condition occurs in *Mikania cuatrecasasii*, *M. holmesiana*, and *M. iserniana*.

c. Corollas with broadly expanded throats with the teeth cut deeply into the throat so that the length of the teeth exceeds that of the throat. This is typical of the remaining species of the group (*Mikania hensoldiana*, *M. speciosa* , *M. trimeria*, *M. allartii* , *M. vaupesensis*, *M. boomii*, *M. latifolia*, *M. oopetala*, and *M. trinitaria*).

Funnelform to narrowly campanulate corolla throats with the teeth being about the same length as the throat appears to be the most common condition in *Mikania* with corymbiform capitulescences. This indicates that there are two trends in the corollas of the group—to very short corolla teeth and to very long corolla teeth. Other *Mikania* mentioned as natural groups (e.g., *M. banisteriae* DC., *M. scandens* (L.) Willd., *M. lindleyana* DC., *M. swartziana* Griseb., etc.) have more

uniform cutting of the corolla teeth into the throat among the various species. In *Mikania* each corolla tooth has two veins with the normal condition being one vein located on each margin. A rare condition is for the veins to be borne inward from but parallel to the margins, such as in *M. anisidora* Hassler, *M. lindleyana* DC., *M. holwayana* B.L. Rob., *M. salviaefolia* Gardner, and several others. Without exception, corollas of these species have broadly expanded throats that are much shorter than the teeth. This position of the nerves imparts a "double nerved" appearance to each margin of the corolla teeth and seems caused by proliferation of additional tissue on the distal side of the nerve. In effect, this makes each tooth wider, thus creating a more expanded throat. This syndrome seems particularly well-developed in the species of the *M. parviflora* group that have corollas of type three described above. It may be difficult to discern in poorly preserved materials or in immature corollas. Often it is more pronounced near the base of the teeth and is best detected by use of a wetting agent and 10–30 × magnification.

Hirsute style appendages and bases are considered to be the signature trait of the group (Figs. 1, 2). The trichomes of the style appendages are unicellular, 80–120 μ long, rather dense, and antrorsely disposed. This trait is best developed in *Mikania parviflora* and *M. guaco*, but even in these two species there is a considerable range of expression. Presumably the function of the hirsute style appendages is to increase the efficiency in which the pollen is pushed from the anther tube. Other functions may include increased ability to retain pollen among the trichomes, thus increasing proficiency of self-pollination, should this occur, or for adherence to objects such as insect legs to increase the length of a visit, or adherence to other stigmas, pappus, etc. to limit curving of the stigmas, hence preventing selfing. This trait is unusual in *Mikania*, but has been noted in other species (e.g., *M. alvimii* R.M. King and H. Rob. and *M. populifolia* Gardner). The lower 1–2 mm of the style bases are also hirsute, but the trichomes are shorter and less dense than those of the appendages, possibly reflecting a vestigial condition.



In the twining *Mikania* with corymbiform capitulescences, there is a tendency toward cordate leaf bases and palmate or trinervate venation. For example, 17 of the 24 *Mikania* that are twining and have corymbiform capitulescences treated in Barroso (1958) exhibit both of these traits. The leaves of the *M. parviflora* group are ecordate and not trinervate or palmately nerved, with the exception of *M. latifolia*, which has leaf bases that may be subcordate to shallowly cordate.

There are several trends apparent in leaf morphology. Species with narrow (lanceolate) leaves tend toward pinnate venation with the secondary nerves being more or less evenly disposed over the entire length of the blade. The leaf bases are normally acute. Ovate-leaved species tend toward subpinnate venation with 2–3 pairs of secondary nerves originating within the basal portion of the blade. The bases are normally truncate to obtuse to shortly cuneate. More rotund leaved species have subpinnate venation with the secondary nerves originating within the basal one-fourth of the blade, but tend to have bases that are cuneately decurrent upon the petioles. Leaf apices in all species are mostly acute to acuminate to shortly caudate. Margins in most species are entire but are finely denticulate in *Mikania allartii* and coarsely dentate in *M. hensoldiana*. Though not morphological, it has been observed that occasional specimens of the various species may have purplish coloration, particularly on the ventral surface. This appears related to environmental conditions, such as shading.

Interpetiolar nodal discs, or stipuliform appeandages, which seem to attain their best develoment within the corymbiform-capitulescenced *Mikania*, are lacking or poorly developed in the group. Items not discussed, such as pappi, cypselae, etc., did not appear relevant to the study.

Distribution

The general distribution of the *Mikania parviflora* group is from southern Mexico throughout Central America to the Amazon Basin of Peru, Bolivia and Brazil, and the West Indies (Figure 3). This is basically the distribution of the most common member of the group, *M. guaco,* but with the exclusion of the West Indies and with the addition of outliers in eastern Brazil and Paraguay. Other widespread species include *M. parviflora*, which is known from southern Panama southward throughout northern South America to Peru, Bolivia, and Brazil, and *M. trinitaria* which occurs in northern South America from Colombia, northern Amazonan Brazil to the Guianas, Trinidad, and several of the Lesser Antilles. One species, *M. oopetala*, is endemic to Cuba, while another, *M. latifolia*, is endemic to various islands of the Lesser Antilles. The remaining species have very restricted distributions with most being concentrated in northwestern South America. *Mikania allartii*, *M. trimeria*, and *M. hensoldiana* are known only from the type, while *M. dictyophylla*, *M. holmesiana*, *M. iserniana*, *M. tafallana*, *M. boomii*, *M. cuatrecasasii,* and *M. vaupesensis* are known from the types and one to several additional specimens of each species. The exceptions to the latter distributions are *M. neei*, known only from the type, which occurs in southern Mexico, and *M. speciosa*, which occurs on the eastern slopes of the Andes of Bolivia, Ecuador, and Peru. The group is conspicuously absent from the major concentration of *Mikania* species, eastern and southeastern Brazil (but see *M. guaco*). Specific information about individual distribution is treated under each species.

Relationships of the *Mikania parviflora* group

It has been mentioned that the *Mikania parviflora* group is thought to be derived from the pedunculate capitulated corymbiform *Mikania*, as represented by *M. scandens*, *M. cordifolia*, etc. While it appears that the corymbiform *Mikania* form a natural group, it is not known at what rank the group should be recognized. The *M. parviflora* group is here considered to be a subset of the corymbiform *Mikania*. At this time it is not possible to subdivide the *M. parviflora* group into subgroups. It would seem natural to use the highly variable amount of cutting of the corolla teeth into the throat (i.e., length of corolla teeth) as a basis for this purpose. Unfortunately, while this trait is very useful for specific delimitation, it appears useless for determining relationships between species. Basically, there appears to be massive instability within this trait in the various members of the *M. parviflora* group. Instability in *Mikania* corollas has been mentioned by Holmes (1995), King and Robinson (1987), and others. Other recognized affinities (*M. banisteriae*, *M. swartziana*, *M. scandens*, *M. lindleyana*, etc., all named after the oldest named member) have corollas exhibiting

unfaltering stability. In these groups, the corolla may be used to define the group but is not serviceable for delimiting species.

The key presented below uses corolla characters for distinguishing species but does not reflect phylogeny.

Taxonomic treatment of the *Mikania parviflora* group

Vines. **Stems** terete to hexagonal. **Leaves** opposite (or whorled in one species), subpinnate to pinnate (very rarely trinervate or palmate), bases cuneate-decurrent, cuneate, to truncate (subcordate to shallowly cordate in one species), interpetiolar discs poorly developed or lacking. **Capitulescence** corymbiform. **Capitula** sessile or nearly so to occasionally pedunculate, disposed in clusters of threes. **Pappus bristles** capillary. **Style appendages and bases** hirsute.

In the treatments of species only one specimen per country is cited if the species is widely distributed. All specimens examined are listed for those species known from few collections.

KEY TO THE SPECIES

1. Corolla teeth shorter than the length of the throat (2).
1. Corolla teeth longer than or equal to the length of throat (6).

2. Leaves elliptic-ovate, oblong-ovate, to ovate, upper surfaces smooth; subinvolucral bracts oblanceolate to obovate to spatulate-elliptic, one-half to nearly as long as the phyllaries (3).
2. Leaves ovate-rotund, upper surfaces asperous to scabrid; subinvolucral bracts subulate to linear to linear-lanceolate, less than one-half the length of the phyllaries (4).

3. Leaves lance-ovate, pinnate with the secondary nerves evenly disposed over the entire length of the blade..... **M. neei**
3. Leaves ovate to elliptic-ovate to oblong-ovate, subpinnate with the seconday nerves originating within the basal one-fourth of the blade ..... **M. parviflora**

4. Leaf bases prominently cuneate-decurrent upon the petioles; capitula 8–10 mm long, corolla teeth deltate, never more than 1 mm long (usually 0.5–0.6 mm long) ..... **M. guaco**
4. Leaf blades rounded to shortly cuneate at insertion of the petioles, capitula 12–14 mm long, corolla teeth lanceolate to triangular, 1–1.5 mm long (5).

5. Leaf undersurfaces densely tomentellose ..... **M. dictyophylla**
5. Leaf undersurfaces glabrate to puberulent mainly on the nerves and veins ..... **M. tafallana**

6. Leaf bases conspicuously long cuneate-decurent upon the petioles (7).
6. Leaf bases acute to rounded or at most shortly cuneate upon the petioles (8).

7. Corolla teeth linear-lanceolate, ca. 3 mm long, corolla throat very short, apparently lacking ..... **M. hensoldiana**
7. Corolla teeth oblong ca. 1.5 mm long, about twice the length of the throat ..... **M. speciosa**

8. Corolla teeth about same length as the throat (9).
8. Corolla teeth 1.5—5× the length of the throat (11).

9. Plants densely crisped pubescent to densely villous ..... **M. holmesiana**
9. Plants glabrate to glabrous (10).

10. Phyllaries ca. 2 mm wide; leaves narrowly elliptic to elliptic-ovate ..... **M. cuatrecasasii**
10. Phyllaries ca. 3 mm wide; leaves lance-ovate to rotund ..... **M. iserniana**

11. Nerves of corolla teeth borne at the margins (12).
11. Nerves of corolla teeth borne inward (submarginal) but parallel to the margins (13).

12. Leaves whorled (3 at a node), about 1 cm wide ..... **M. trimeria**
12. Leaves opposite, much greater than 1 cm wide (14).

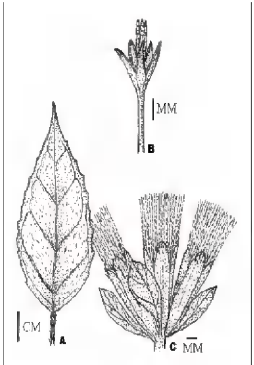
13. Leaf margins denticultate, surfaces setose-hispid ..... **M. allartii**
13. Leaf margins entire, upper surfaces glabrate, the lower at most puberulent ..... **M. vaupesensis**

14. Leaves elliptic, 4 cm or less long ..... **M. boomii**
14. Leaves ovate to broadly ovate, greater than 5 cm long (15).

15. Leaf bases mostly subcordate to shallowly cordate; stems terete ..... **M. latifolia**
15. Leaf bases rounded; stems hexagonal or subhexagona (16).

16. Subinvolucral bracts linear, ca. 0.7 mm long ..... **M. oopetala**
16. Subinvolucral bracts ovate-lanceolate, 2 mm long or longer ..... **M. trinitaria**

1. ***MIKANIA ALLARTII*** B.L. Rob., Contr. Gray Herb. 96. 23. 1931. **TYPE: Venezuela**. Los Venados near Caracas, Oct 1924, *Allart 112* (holotype: US!; isotype: VEN). Figure 4.

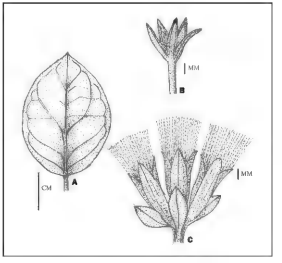


Stems terete, glabrate, striate, solid, younger parts glabrate to hispid to setose-hispid, striate, internodes 4–16 cm long. Leaves lance-ovate to ovate, 5.3–8.0 × 1.9–3.0 cm; apices acuminate, margins denticulate, the teeth 2–5 mm distant, bases obtuse, surfaces pinnately nerved, upper surfaces setose-hispid, the nerves and veins obscured, lower surfaces densely setose-hispid, glandular, nerves and veins prominent, exserted from the surface, densely setose-hispid; petioles 6–10 mm long, densely setose hispid. Capitulescence ca. 13 × 8 cm; branchlets setose-hispid; bracts similar to leaves but reduced in size. Capitula 12–14 mm long; subinvolucral bracts ovate to obovate, 5–8 mm long, apices acute-acuminate, margins entire, bases narrowed and somewhat petiolate in appearance, surfaces setose-hispid, glandular, positioned at the very base of the phyllaries for both lateral and medial capitula. Phyllaries narrowly oblong, 8–9 mm long, the outer setose-hispid, glandular, apices rounded, densely setose hispid, the inner glabrate except for few scattered globular glands, the apices rounded, setose-hispid. Corollas ca. 6 mm long, tubes 3–3.5 mm long, the bases not noticeably enlarged; throats funnelform, ca. 0.8 mm long, teeth lanceolate, ca. 1.6 mm long, glandular, veins marginal. Pappus bristles rufous in age, 36–42, 6–6.5 mm long, margins scabrid. Cypselae ca. 4.8 mm long, glabrate, glandular, particularly at the summit.

Distribution and phenology. Known only from the type collected in Venezuela; flowering in October.

Mikania allartii is distinctly marked by its leaves that have denticulate margins, pinnate venation, and densely pubescent undersurfaces. Of note are the subinvolucral bracts that are quite large (more than one-half to nearly as large as the phyllaries), with those of the medial capitula always borne at the very base of the involucre.

2. ***MIKANIA BOOMII*** Pruski, Mem. N.Y. Bot. Gard. 64: 44. 1990. **TYPE: Guyana**. Upper Potaro River Region: Summit ofunt Wokomung, 5º 05' N, 59º 50' W, 1650 m, 2 Jul 1989, *Boom & Samuels 9040* (holotype: NY; isotype: US!). Figure 5.



Stems subterete to slightly angled, pubescent when young, densely tuberculate in age; internodes 1.5–5 cm long. Leaves coriaceous (fleshy?), elliptic to broadly elliptic, 1.7–3.9 cm × 1–1.9 cm, apices acute to obtuse, margins entire to occasionally remotely denticulate, revolute, bases cuneate to rounded, pinnately veined with about 3 pairs of secondary veins originating within the basal half of the blade, upper surfaces rugose, shiny, glabrate, lower surfaces pubescent, densely glandular, strongly reticulate with veins flattened in a vertical plane (suggesting a fleshy nature); petioles stout, 2–3.5 mm long, pubescent. Capitulescence 3–4 cm tall and 3–7 cm broad; the capitula sessile or occasionally borne on peduncles 0.5–3 mm long, this more common on the lateral capitula. Capitula 9–11.5 mm long; subinvolucral bracts obovate, 3.5–5 mm long, apices acute to obtuse, those of the lateral pair of capitula borne at the very base of the involucre, those of the medial capitula borne at or slightly below the point of origination of the outer capitula or (if present) peduncles of the outer pair of capitula. Phyllaries elliptic-obovate, 8–9 mm long, apices rounded to slightly acute, puberulent, surfaces of the outer pair somewhat pubescent and glandular, surfaces of the inner pair glabrate except for the apices. Corollas 6.5–7 mm long, white, tubes ca. 3 mm long, throats broadly campanulate, ca. 0.6 mm long, teeth linear, ca. 3 mm long, apices slightly puberulent and glandular, the veins borne inward and parallel to the margins thus imparting a "double nerved" appearance. Pappus bristles white, 60–65, 7.5–8.5 mm long, margins scabrid, apices not thickened. Cypselae obconic, 5.2–5.8 mm long, brownish, glabrous.

Distribution and phenology. Known only from Guyana; 1650–2000 m elevation; flowering June–November.

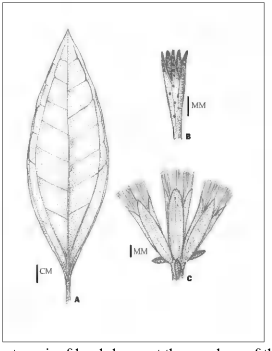
Additional specimens. **Guyana**. Cuyuni-Mazaruni. Pakaraima Mts, 2 km transect along summit-ridge, Mt. Ayanganna, N 5º 23', W 59º 59', 1800–2000 m, 3 Nov 1992, *Henkel 128 & Hoffman* (US); Potaro-Siparuni, Mt. Ayanganna, N 5º 23'12", W 59º 59' 36", 19 Jun 2001, *Clark 9381, Williams, Perry, & Kelly* (US).

The revolute margins and veins flattened in a vertical plane (both in the dried state) suggest that the leaves may possess a fleshy nature. Leaves are also uniformly elliptic in shape, small in size for the group, with none exceeding 4 cm in length on the three specimens from which this species is known. Leaves also have short petioles compared to the size of the blades. Additionally, the lower surfaces of the leaves are densely glandular and the margins may occasionally be remotely

denticulate. It is important to note that *Mikania* specimens most often consist of the capitulescence and nearby leaves, rarely do they include cauline leaves or other structures from lower portions of the plant. My experience has been that lower cauline leaves often differ greatly from the upper leaves in size, shape, basal lobing, and other characteristics (see Holmes 1995 for additional information.

Pruski (1990) reported the lack of a subinvolucral bract for the medial capitulum of the sessile clusters of three, but, as mentioned in the description above, they are borne at or slightly below the point of origin of the lateral capitula or their peduncles.

3. **MIKANIA CUATRECASASII** W.C. Holmes, Phytologia 65: 242. 1988. **TYPE**: **Colombia**. Del Valle, Costa del Pacifico, Río Yurumangui, El Papayo, 10–100 m, 5 Feb 1944, *Cuatrecasas 15995* (holotype: F!; isotypes: COL!, F!, US!). Figure 6.



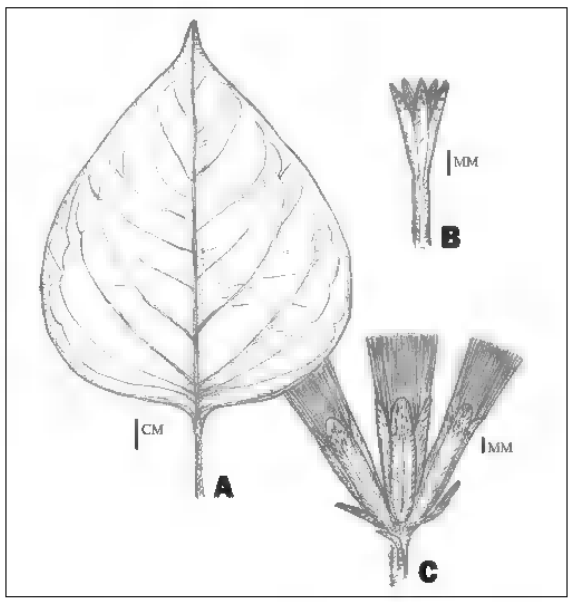
Stems terete, costate-striate, glabrate, pithy; internodes 6–23 cm long. Leaves narrowly elliptic to elliptic-ovate, 10–17 × 2.7–5 cm, subpinnately 5-nervate, the first pair of nerves rather obscure, originating at the very base of the blade, arching forward and somewhat paralleling the margins to about the upper one-third of the blade, the second pair originating with 1.5–2 cm of the base, more conspicuous than the first, imparting a trinervate appearance, arching forward parallel to the margins and extending nearly to the apex, the tertiary veinlets somewhat prominent, slightly antrorse disposed and forming a fairly prominent transverse pattern between the midrib and secondary nerves; apices acute to acuminate, margins entire, bases attenuate; surfaces glabrous; petioles 1–1.5 cm long, glabrous. Capitulescence 7–10 × 8–11 cm; branchlets striate, glabrate to puberulent; bracts narrowly elliptic, 1–2 cm long, petiolate, otherwise similar to leaves. Capitula 7–8 cm long; subinvolucral bracts ovate, 1–1.5 mm long, glabrous, apices acute, those of the outer pair of heads borne at the very base of the peduncle, those of the median capitulum borne 1–2 mm below the involucre. Phyllaries oblong-elliptic, ca. 7.2 mm long, apices rounded, hispid, bases slightly swollen, the outer puberulent, glandular, the inner glabrous. Corollas white, 4.3–4.7 mm long, sparingly glandular; tubes 1.7–2 mm long; throats tubular, 1–1.5 mm long; teeth lanceolate, 1–1.3 mm long, glandular. Pappus bristles white, 35–40, ca. 5 mm long, margins obscurely scabrid (visible at 30×). Cypselae (immature) ca. 1.5 mm long, densely glandular at the very summit.

Distribution and phenology. Known only from Del Valle and Chocó, Colombia; lower Pacific slopes from 10–100 m; flowering February to April.

Additional specimen: **Colombia**. **Chocó**. Carretera Quibdó-Guayabal, Duata, margen derecha de Río Duata, 40 m, 27 Apr 1975, *Forero, Jaramillo, & McElroy 1261* (COL).

The narrow elliptic to elliptic-ovate leaves with the major nerves originating within the basal 2 cm of the blade and the slightly antrorse disposed transverse pattern of the tertiary veinlets between the midrib and secondary nerves characterize the species. Other notable traits of this species are its glabrate stems and leaves and the corolla teeth that are about the same length as the throat.

4. **MIKANIA DICTYOPHYLLA** B.L. Rob., Contr. Gray Herb. 64: 8. 1922. **TYPE**: **Colombia**. **Huila**. On Cordillera Oriental E of Neiva, 1300-1800 m, 1–8 Aug 1917, *Rusby & Pennell 1004* (holotype: NY; phototype: US!). Figure 7.



Stems dark purple to brownish, terete, fistulose, glabrate to scabrid. Leaves thickish, firm, lance-ovate to ovate, 2.3–9.5 × 7–17 cm; apices acute to acuminate, margins entire, bases rounded to a short acumination at insertion of the petiole, subpinnately nerved with 2–4 pairs of secondary nerves originating within the basal 2–4 cm of the blade; upper surfaces scabrid and rugose, lower surfaces tomentellose, prominently reticulate, the veinlets exserted from the surface; petioles 1.2–3.4 cm long, tomentellose. Capitulescence 5–10 cm tall and 7–16 cm wide; capitula 12–14 mm long; subinvolucral bracts linear to lanceolate, 2.5–3.5 mm long, glabrate to puberulent, those of the outer pair of capitula borne at the very base of the involucre, those of the center capitula borne 1–4 mm below the involucre. Phyllaries oblong, ca. 8 mm long, apices rounded, puberulent, the outer pair puberulent, the inner glabrate. Corollas white, ca. 7 mm long, glandular, tubes 3–4 mm long, gradually expanded into the funnelform throat, ca. 3 mm long, teeth triangular, 1–1.5 mm long, the nerves marginal. Pappus bristles white, 60–70, ca. 8 mm long, margins scabrid, apices sometimes thickened. Cypselae 4–5 mm long, glabrate, glandular at the summit.

Distribution and phenology. Known only from Colombia; 1300–1800 m elevation; flowering all year (?).

Additional specimens: **Colombia**. **Antioquia**. San Antonio, Dec 1937, *Daniel 2236* (US); Valle, Mpio. Bolivar, Alto de los Viejos, finca El Porvenir, via Primavera-Trujillo, 1650 m, 27 Feb 1985, *Devia A. 995* (US); Mariquita, 1854, *Triana 1243* (P).

In overall appearance, this species is similar to *Mikania guaco*, but Robinson (1922) remarked that it differs in its more thicker and more reticulated leaves with a general lack of prominent cuneate-decurrent leaf bases, although a photo of the holotype shows the upper leaves to be amply decurrent upon the petioles. While cuneate–decurrent leaf bases are characteristic of *M. guaco*, the condition varies greatly as to expression and is not present on all specimens of the species. More reliable traits distinguishing the two species are the shape and length of corolla teeth, with those of *M. dictyophylla* being longer and narrower, as mentioned in the key to species. Even more similar is the Ecuadorian *M. tafallana*, which has corolla teeth closely approaching the size and shape of *M. dictyophylla*. Ample distinction, based upon leaf characteristics, is presented in the key to species. There are other differences in the corollas. In *M. tafallana*, the throat is about 2× the length of the tube while in *M. dictyophylla* the throat and tube are nearly equal in length. While the mentioned traits seem to adequately distinguish the two species, it is important to note that both species are known from very few specimens (three for *M. tafallana* and four for *M. dictyophylla*) that probably do not express the total range of variation present in either species. While the differences in corollas seem a more precise character, experience has proven it to be a difficult character to discern and, depending upon the developmental state of the corolla, often misleading.

Mikania dictyophylla is characterized by the purple-brownish color of stems and leaves and capitula 12–14 mm long. Flower color of the type was reported as cream-yellow by Rusby and Pennell, which may be attributed to age and or the presence of pollen.

5. **MIKANIA GUACO** Humb. & Bonpl., Pl. Aequinoct 2: 84. t. 105. 1810-11. *Mikania amara* Willd. var. *guaco* (Humb. & Bonpl.) Baker in Mart. Fl. Bras. 6(2): 237. 1876. *Willoughbya guaco* (Humb. & Bonpl.) Kuntze, Rev. Gen. 1: 372. 1891. **TYPE: Colombia**. Magdalena River between Mahates & Angostura, *Humboldt & Bonpland 1447* (holotype: P). Figure 8.

Mikania huaco Rieux ex Spreng, Syst. Veg. Fl. Peruv. Chil 3: 422. 1826, nom. nud.

Mikania aspera Miq., Linnaea 17: 68. 1843. **TYPE**: *Focke 209* (holotype: U?; phototype: P!).

Mikania argyrostigma Miq., Linnaea 17: 69. 1843. **TYPE**: *Focke 460* (holotype: U; phototype: P!).

Mikania brachiata Poepp. in Poepp. & Endl., Nov. Gen. Sp. Pl. 3: 53. 1845. **TYPE: Peru**. In forests at Tocache, *Poeppig 2041* (holotype: W; isotype F! photo and fragment).

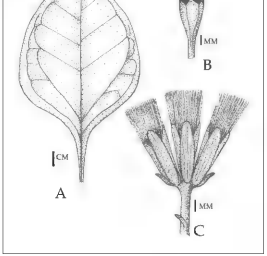
Mikania cuneata Schultz-Bip., Bonplandia 4: 54. 1856 (nomen nudum). **TYPE: Peru**. San Govan, *Lechler 2477* (holotype: K?; isotype: F!).

Mikania olivacea Klatt in Th. Dur. & Pittier, Bull Soc. Roy. Bot. Belg. 31: 195. 1892. **TYPE: Costa Rica**. Forests of Buenos Aires, *Pittier 4433* (holotype: BR!; isotype: GH!).

Mikania archidonensis Cuatrec., Anal. Univ. Madrid 4: 234. 1935. **TYPE: Ecuador**. Archidona, Apr-May 1865, *Isern 72* (holotype: MA; isotype: F, phototype: US!).

Mikania napensis Blake, J. Wash. Acad. Sci. 28: 484. 1938. **TYPE: Ecuador**. Near Archidona, 650 m, 19 Apr 1935, *Mexia 7259* (holotype: US!).

Mikania zonensis King & H. Rob., Phytologia 28: 275–276. 1974. **TYPE: Panama**. Canal Zone. Albrook, U.S. Army Tropic Test Center Site, Apr 1965, *Dwyer & Robyns 115* (holotype: MO!; isotype: US!) [See comments on type in discussion.]



Stems terete, pithy to hollow, glabrous to puberulent to pilose and glandular (especially the younger); internodes to 20 cm or more long. Leaves blades ovate-oval, 10–20 × 4–12 cm or greater, margins entire to obscurely denticulate, apices acuminate, bases normally very prominently decurrent upon the petiole, occasionally shortly so, upper surfaces puberulent to more often scabrid, pinnately nerved with 2–3 pairs of more prominent secondary nerves originating in the basal one-fifth of the blade, lower surfaces glabrate to puberulent, glandular; petioles 2.5–5 cm long, thin, puberulent. Capitulescence rather dense, to 6–12 cm, branchlets angled, puberulent. Capitula 8–10 mm long, sessile or occasionally shortly pedunculate, especially the outer pair of capitula. Subinvolucral bracts subulate to linear, 0.5–2 mm long, puberulent, those of the outer capitula borne at the very base of the phyllaries, those of the medial capitula usually borne about midway down the peduncle that supports the three capitula. Phyllaries oblong, 4–6 mm long, the outer puberulent, glandular, apices rounded densely puberulent, the inner glabrate, except for the puberulent rounded apices. Corollas 5–6 mm long, white to lilac to brownish, glandular, tubes 2–3.5 mm long, throats ca. 2–2.4 mm long, teeth deltate, 0.5– 0.6 mm long. Pappus bristles ca. 60, white (to buff in age), ca. 4–6 mm long, scabrid, slightly thinning toward the apices. Cypselae ca. 3 mm long, blackish, glabrate to puberulent.

Distribution and phenology. Southeastern Mexico (east of about 96°) south to the Amazon Basin of South America (Brazil, Bolivia, and Peru), also Rio de Janeiro, Brazil and northeastern Paraguay; to about 1750 m, but generally below 500m; flowering all year. Figure 9.

Representative specimens. CENTRAL AMERICA. **Belize**. Jacinto Creek, 6 Mar 1934, *Schipp S-739* (US). **Costa Rica**. San José. Vicinity of El General, Jan 1936, *Skutch 2363* (US). **Guatamala**. Izabal, between Virginia and Lago Izabal,Montaña del Mico, 4 Apr 1940, *Steyermark 38778* (F). **Honduras**. Atlántida, vicinity of Tela, 14 Dec-15 Mar 1928, *Standley 54769* (US). **Panama**. San Jose Island, Perlas Archipelago, Gulf of Panama, ca. 55 mi SSE of Balboa, 13 Feb 1946, *Johnston 1372* (US). **Nicaragua**. Matagalpa, Cerro Musun, Quebrada El Jobo, a tributary of Río Paiwas, 12 Feb 1979, *Stevens 12002* (US). **Mexico**. **Oaxaca**. Matior Romero, orilla N Río Verde, 6.4 km SE de Aserrado La Floresta sobre camino a arroyo Amaca, 30 Nov 1981, *Wendt el al 3546* (TEX). SOUTH AMERICA. **Bolivia**. Junction of Rivers Beni and Madre de Dios, Aug 1886, *Rusby 1650* (US). **Brazil**. Amazonas, Rio Purus between Santa Maria & Mari north of Lábrea, 22 Jun 1971, *Prance 13452 et al.* (US). **Colombia**. Del Valle, Costa del Pacífico, Río Cajambre: Silva, 13 May 1944, *Cuatrecasas 17549* (US). **Ecuador**. Pastaza, Río Curiacu, ca. 8 km W of Puerto Sarayacu, 19 Oct 1974, *Lugo S. 4270* (US). **French Guiana**. Route de Paul Isnard, PK 80 environ près d'une crique, 7 Nov 1982, *Fournet 298* (US). **Guyana**. Barima-Waini Region: Barima River capitulum, 3 mi W Eclipse Falls, W of Arakaka, 5 Aug 1986, *Pipoly 8299* (US). **Paraguay**. Mbaracayu Natural Reserve, 2 km N of Jejui-Mi, 12 Jun 1998, *Zardini & Chaparro 48742* (US). **Peru**. Loreto, Maynas, Dtto. Iquitos, Río Itaya, trocha de Sanangal, 2 Mar 1980, *McDaniel 23290 & Rimachi* (US). **Surinam**. Kayser Airstrip, Zuid River 45 km above confluence with Lucie River, 27 Sep 1963, *Irwin 57671 et al.* (US). **Venezuela**. Amazonas, Cerro de la Neblina, 14 Feb 1984, *Funk 6194* (US).

Mikania guaco is the most widely distributed and often collected member of the group. Holmes (1990) reported the species as occurring as far north as Tampico, Tamaulipas, Mexico. It has also been collected at São João da Barra, Rio de Janeiro, Brazil (*Glaziou 9916*, P), which is about 2000 km southeast of its nearest occurrence in the Amazon Basin, and at Caaguazu, Paraguay, about 1100 km south of its nearest location in Bolivia (Holmes 2001).

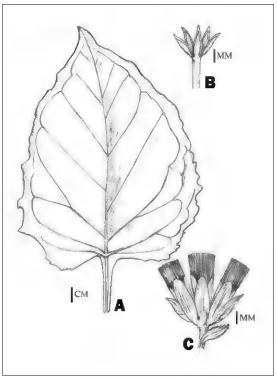
The species is characterized by its ovate to broadly ovate leaves with the bases being cuneately decurrent on the petioles. There are, however, numerous specimens where this trait is lacking or less than readily apparent. Occasional specimens may have leaves with truncate or even subcordate bases. The upper leaf surfaces are normally scabrid, a trait occasionally found in *M. tafallana*, *M. speciosa*, and *M. dictyophylla*.

Capitula are not always strictly sessile in this species. Occasionally the lateral capitula are rather long pedunculate (up to 5 mm), while the medial capitulum is sessile or occasionally shortly pedunculate. The subinvolucral bracts of the outer pair of capitula are always borne at the very base of the involucre, while those of the medial capitulum are several mm below the involucre, or point of origin of the peduncles (if present) of the lateral capitula. All are small as compared to the size of the phyllaries.

Mikania guaco is similar to *M. speciosa* in overall appearance, but that species is distinguished by its corolla teeth being much greater in length than the throat. Refer to *M. dictyophylla* and *M. tafallana* for comparison with other similar species.

Mikania zonensis of Panama was reduced to a synonym of *M. guaco* by Robinson and Holmes (2008). The type consists of fertile fragments of *M. guaco* (hence the selection of these fragments as lectotype) and leaves that appear to be from *M. leiostachya* Benth. or some species of non-Asteraceae. *Mikania attenuata* DC., long considered as a synonym of *M. guaco*, is now considered to be a synonym of *M. speciosa*.

6. **MIKANIA HENSOLDIANA** I. Sánchez & M.O. Dillon, Arnaldoa 7: 7. 2000. **TYPE: Peru**. Piura. Prov. Huancabamba, ca. 3 km N of Canchaque, ca. 1730 m, 22 Jul 1991, *Dillon & Sánchez V. 6322* (holotype: F; isotypes: BAYLU!, US!). Figure 10.

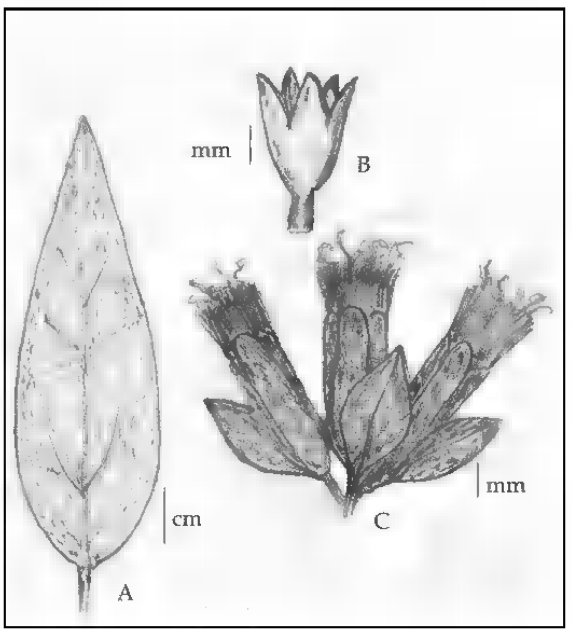


Stems striate-costate, villous to tomentose, particularly above, internodes 6–16 cm long. Leaves broadly ovate to ovate-deltate, 12–20 × 6–13 cm, apices acute to short acuminate, margins coarsely serrate-dentate, bases cuneately decurrent upon the petiole from a rounded to truncate to subcordate contour, pinnately nerved with two pairs of nerves originating within the basal 2 cm of the blade proper, upper surfaces glabrate to puberulent, lower surfaces villous; petioles 2–5.5 cm long, villous; interpetiolar discs lacking. Capitulescense corymbiform, 3–6 × 6–16 cm, capitula disposed in sessile clusters of threes. Capitula ca. 14 mm long; subinvolucral bracts elliptic-lanceolate to oblanceolate-spatulate, 7–9 mm long, apices acute to acuminate, margins long ciliate, bases attenuate, abaxial surfaces villous, adaxial surfaces glabrate, those of the lateral capitula borne at the very base of the phyllaries, those of the medial capitula borne about midway down the peduncle. Phyllaries oblong, 9–10.5 mm long, apices rounded to obtuse, villous, glandular, surfaces of the outer pair villous, glandular, surfaces of the inner pair sparingly pilose-villous. Corollas white, ca. 6.5 mm long, tubes ca. 3 mm long, throats very short (0.2–0.3 mm) and appearing lacking, teeth linear-lanceolate, ca. 3.2 mm long, the veins borne inward and parallel to the margins (more noticeable in the upper half), thus giving the appearance of being double nerved. Pappus bristles white, ca. 60, 7–7.5 mm long, margins scabrid. Cypselae ca. 6 mm long, olivaceous, surfaces glabrate to pilose, slightly glandular at the summit.

Distribution. Known only from the type collected in Piura, Peru; ca. 1730 m; flowering in July.

Mikania hensoldiana is characterized by its linear-lanceolate corolla teeth that are very deeply cut into the throat, which appears lacking. The leaf bases, which are conspicuously decurrent upon the petioles, resemble those of *M. dictyophylla, M. guaco, M. speciosa*, and *M. tafallana*, all of which occur in Peru and/or Ecuador. The apparent lack of a corolla throat distnguishes *M. hensoldiana* from these species, all of which have ample corolla throats.

7. **MIKANIA HOLMESIANA** Pruski, Phytoneuron 2012-32: 9-13. **TYPE**: **Peru**. Amazonas, Bagua, Dtto. Imaza: Quebrada Almendra, Cerro Tayu, 5°15' 56" S, 78°22' 07" W, 1200 m, 20 Jul 2004, *Rojas, Vasquez, & Apanu 3165* (holotype: MO!; isotypes BAYLU!, USM). Figure 11.



Stems subterete, densely crisped pubescent to densely villous. Leaves laceolate to lanceolate-ovate, lanceolate-ovate, 2.5–6.3 × 1.3–2.9 cm, apices acute, margins entire, bases cuneate to obtuse, surfaces brownish crisped-pubescent; venation pinnate with 2 pairs of nerves originating within the basal 1.5 cm of the base, these arching forward to midblade or beyond; petioles 0.3–1.3 cm long, densely crisped pubescent to densely villous. Capitulescence 5–9 × 8–10 cm, branchlets densely crisped pubescent to densely villous; capitula 7–8 mm tall, sessile to subsessile. Subinvolural bracts spatulate to oblong, 3–5 × 1–1.8 mm , ca. one-half the length of the involucres, densely crisped pubescent to densely villous. Phyllaries lanceolate, 4–5 mm long, surfaces of the outer pair crisped pubescent to villous, the inner more or less grabrate except for the crisped puberulent apices, apices obtuse to rounded. Corollas white, 3.4–3.9 mm long, throat campanulate, 1.2–1.5 mm, teeth lanceolate ovate, 1.1–1.2 mm, tube. Pappus bristles pale brown, 3.5–4.5 mm long, 55–60, margins scabrid. Cypselae 4–5 mm long.

Distribution. Known only from Cerro Tayu, an isolated sandstone mountain in Dpto. Amazonas in northern Peru; elevation 900–1200 m; flowering [June?] –July.

Representative specimens. Peru. Amazonas. Bagua. Dtto. Imaza: Tayu Mujaji, Comunidad de Wawas, 900 m, 23 Oct 1997, *Vásquez, Awanash, & Pitug 24677* (MO); Tayu Mujaji, bosque primario, 900–1030 m, 17 Feb 2002, *Vásquez 27609* (MO).

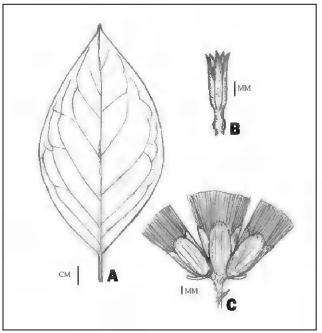
Mikania holmesiana is similar to the well known and widely distributed *M. parviflora*, but is distinguished by its densely crisped pubescent to villous surfaces and corolla teeth that are about the same lenth as the tube proper. *Mikania parviflora* has a fine pubescence and corolla teeth that are much shorter than the teeth.

The species was first recognized by my good botanical friend, John Pruski, who named it in my honor.

8. **MIKANIA ISERNIANA** Cuatrec., Anal. Univ. Madrid 4: 235. 1935. **TYPE**: **Ecuador**. Guayaquil, 1864, *Isern 94* (holotype: MA; isotype: F! photo US!). Figure 12.

Mikania platylepis D. Don ex King & Rob., Phytologia 58: 263. 1985. **TYPE**: **Peru**. without definite locality, *Ruiz & Pavon s.n.* (holotype: BM!, photo US!).

Stems glabrous, terete-striate to irregularly angled, younger parts puberulent; internodes to 15 cm long. Leaves ovate-lanceolate to rotund; blades 6.5–10 × 2.5–6.3 cm; apices acuminate, margins entire, bases obtuse to cuneate-decurrent on petiole; upper surfaces scrabridulous, lower surfaces hispidulous, densely glandular-punctate; venation pinnate, with 3–4 pairs of nerves rather evenly disposed over the blade; petioles 1.3–1.5 cm long, densely hispidulous. Bracteal leaves ca. 4.5 × 2.3



cm, elliptic-ovate, otherwise similar to cauline leaves. Capitulescence 8–13 cm wide and ca. 4.7 cm tall; primary peduncle 2.8–9 cm long, hispidulous. Capitula ca. 11 mm long. Subinvolucral bracts subulate, 1–1.5 mm long, disposed at the very base of the involucre on lateral capitula but borne well down the peduncle on the median capitulum. Phyllaries oblong, 6–7 mm long, ca. 3 mm wide; apices widely rounded to subtruncate, hispidulous; the outer pair disposed laterally, the inner adaxial and abaxial (thus the subinvolucral bract is borne opposite the outermost inner phyllary. Corollas ca. 6 mm long, tube 1–1.3 mm, throat 2–2.3 mm long, teeth lanceolate, 2–2.2 mm long. Pappus bristles ca. 55, 6–6.5 mm long, margins scabrid, rufescent (in age). Cypselae ca. 5 mm long, sparingly glandular pubescent.

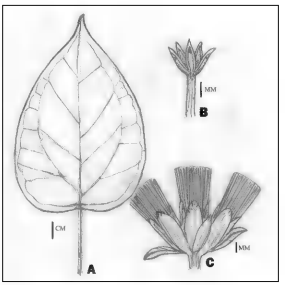
Distribution and phenology. Ecuador and Peru; flowering period unknown.

Representative specimens. Known only from the two type specimens cited above.

Mikania iserniana is well marked by its very broad phyllaries. The rufescent nature of the pappus bristles seems caused by age and/or some treatment during pressing and drying the plants.

9. **MIKANIA LATIFOLIA** J.E. Smith *in* Rees, Cycl. 23, *Mikania* N. 8. 1819. *Willoughbya latifolia* (Smith) Kuntze, Revis. Gen. Pl. 1: 372. 1891. **TYPE: St. Lucia**. collector not indicated (holotype: LINN). Figure 13.

Mikania latifolia J.E. Smith forma *dominicensis* Urb., Symb. Antill. 5: 223. 1907. *Mikania latifolia* J.E. Smith var. *dominicensis* (Urb.) Domin, Acta. Bot. Bohem. 9: 68. 1930. **LECTOTYPE** (Stehlé, Not. Syst. 15: 71. 1954): **Dominica**. *Eggers 998* (C, teste Urban, Symb. Antill. 1:44. 1898).

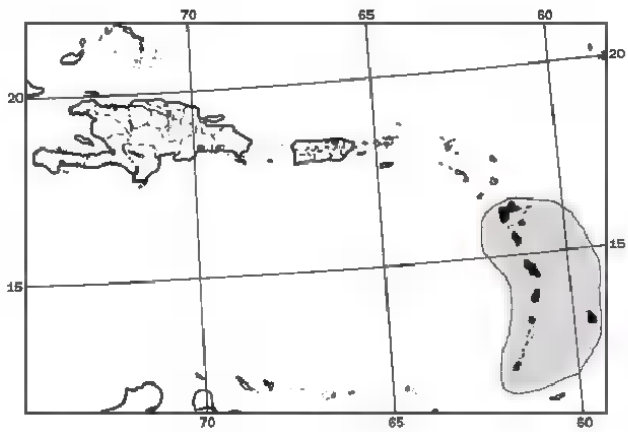


Stems terete to subhexagonal, glabrous; internodes to 31 cm or more long. Leaves broadly ovate to rotund, 3–14 × 2–10 cm, subcordate to shallowly cordate, apices acute to acuminate, margins entire; subpinnately 5-nerved from near the base, upper surface glabrous, veinlets obscure, lower surface glabrate to sparingly puberulent, especially on nerves, reticulate; petioles 0.5–3 cm long, glabrous. Capitulescence ca. 7 × 5 cm, capitula sessile or the lateral occasionally borne on peduncles 1–3 mm long; branchlets terete to angled, puberulent, glandular; bracteal leaves similar to cauline leaves, much reduced in size, puberulent. Capitula 10–13 mm long; subinvolucral bracts oblanceolate to elliptic, 3–5 mm long, puberulent, apices acute to obtuse, borne at the very base of the phyllaries. Phyllaries lance-elliptic to elliptic-ovate, 5–7.5 mm long, nervate; apicesnarrowed to a rounded tip, densely pilose, the outer puberulent, glandular, the inner glabrate. Corollas 4.5–6 mm long, tubes 2–3.5 mm long, throat very short (usually ca. 0.5 mm), teeth lance-linear; 2.3–2.5 mm long, often glandular, nerves borne inward,

but parallel to the margins. Pappus bristles 48–50, 6–7 mm long, margins scabrid. Cypselae 3.5–4 mm long, glabrate, lightly glandular.

Distribution and phenology. The Lesser Antilles from Montserrat south to St. Vincent and Barbados; to about 800 m; flowering November–January, occasionally at other times. Figure 14.

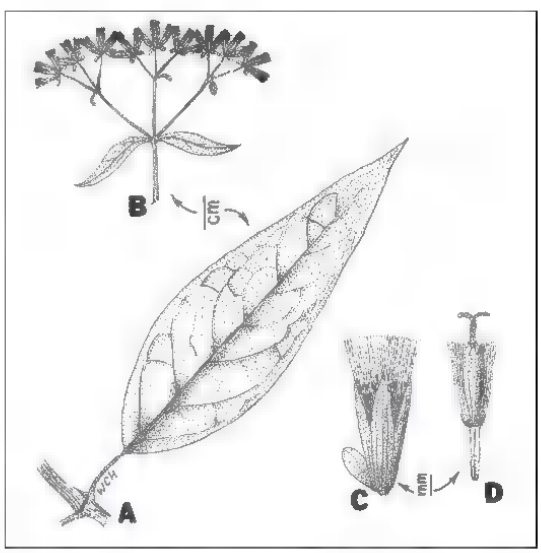
Representative specimens: **Barbados**. Foster Hall wood, Jan 1890, *Eggers 7116* (US). **Dominica**. Near the Fresh Water Lake on southeast side of Morne Micotrin and along old road on side of the mountain 1–1/2 miles E of Laudat, 13 Jan 1966, *Chambers 2568* (US). **Guadeloupe**, 1892, *Duss 2501* (US). **St. Lucia**. Barre de l'Isle trail to Mt. LaComb, 24 Jan 1985, *Howard 19862 et al.* (US).



The species is characterized by its broadly ovate to rotund leaves with subcordate to shallowly cordate bases. The venation of some specimens is very near to being trinervate or palmate. *Mikania trinitaria*, which also occurs in the Lesser Antilles, may be distinguished by its narrower leaves with rounded to more often shortly acuminate bases.

There are no discernable differences to support recognition of the names *Mikania latifolia* f. *dominicensis* or *M. latifolia* var. *dominicensis*.

10. **MIKANIA NEEI** W.C. Holmes, Phytologia 58: 165. 1985. **TYPE: Mexico. Veracruz**. Mpio. Catemaco, E side of entrance of Laguna de Sontecomapan into the Gulf of Mexico, 7 km NE of Sontecomapan, 1 Nov 1981, *Nee 22565* (TEX). Figure 15.

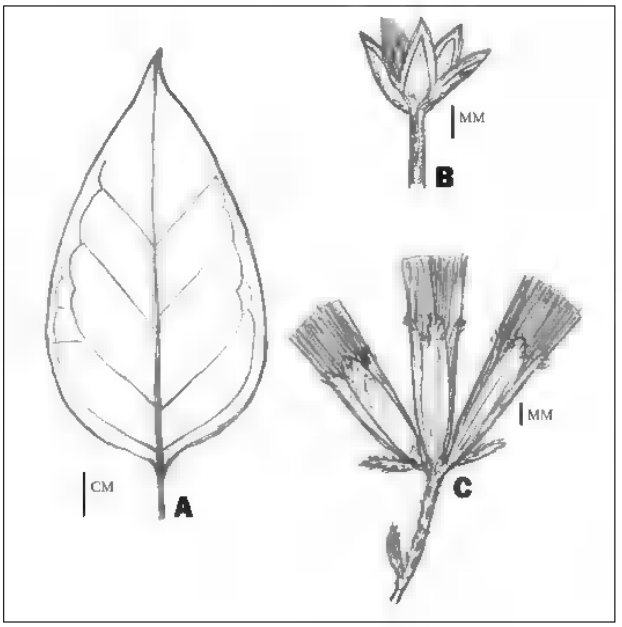


Stems terete, striate, glabrous; internodes 8 cm or more long. Leaves lance-ovate, to 12 × 4 cm, pinnately nerved with about 7 pairs of secondary nerves, these exserted from the surface, of about equal prominence and uniformly distributed along the entire length of the blade, upper surfaces glabrous, lower surfaces puberulent, apices acuminate, margins entire, based obtuse to rounded; petioles ca. 1.8 mm long, puberulent. Capitulescence corymbiform, 4–4.5 × 8–9 cm; branchlets puberulent; bracts similar to leaves but reduced in size. Capitula ca. 8 mm long; subinvolucral bracts oblanceolate to obovate, 3–4.5 mm long, puberulent, apices rounded to acute. Phyllaries elliptic-oblong, 3–5(7) nerved, apices acute to sub- acuminate to a rounded and puberulent tip, the outer pair of phyllaries puberulent, the inner pair glabrate. Corollas ca. 4.5 mm long; tubes ca. 1.4 mm long; throats subcylindric, ca. 2 mm long; teeth triangular, ca. 1 × 0.5 mm. Pappus bristles 40–45, ca. 4.5 mm long, margins scabrid. Cypselae (immature) ca. 2 mm long.

Distribution and phenology. Known only from the type collected in Veracruz, Mexico; 0–50 m elevation; flowering in November.

Mikania neei is characterized by its lance-ovate leaves with pinnate venation with the secondary nerves uniformly disposed over the entire length of the blade. The corolla, with its subcylindric throat and short teeth, indicates near relationship with *M. guaco* and *M. parviflora*. Those species have much broader leaves with the secondary nerves originating within the basal fourth of the blade. *Mikania guaco* also has scabrid upper leaf surfaces and cuneate-decurrent leaf bases, both traits not occuring in *M. neei*. The subinvolucral bracts of *M. parviflora* and *M. neei* have some similarity in shape and size, but those of former species are generally more spatulate , appearing "petiolate" while those of the latter species are oblanceolate to obovate and sessile.

11. **MIKANIA OOPETALA** Urban & Niedenzu, Symb. Antill. 2: 461. 1901. **TYPE**: **Cuba**. Orientali, 1856-7, *Wright 301* (holotype: B, destroyed; isotypes: BR!, F!, MO!, NY!, PH!). Figure 16.



Stems hexagonal, glabrate, the angles winged; internodes to 17 cm or more long. Leaves ovate to elliptic-ovate, 6–20 × 4–13 cm, pinnately nerved; apices acute-acuminate, margins entire, bases rounded to an acumination, upper surfaces glabrous, the veinlets inserted in the surfaces, lower surfaces puberulent, glandular, veins exserted form the surface; petioles to 2 cm long, puberulent, winged. Capitulescence ca. 8 × 8 cm; branchlets angular-flattened, puberulent; bracts similar to leaves but reduced in size. Capitula ca. 10 mm long. Subinvolucral bracts linear, 3–4 mm flower; long, pilose to puberulent, those of the lateral capitula borne at the very base of the involucre, those of the medial capitulum borne about 5 mm below the involucre. Phyllaries elliptic-oblong, ca. 8 mm long, the outer somewhat densely puberulent to pilose, lightly glandular, nervate, apices rounded, densely pilose, the inner glabrate except for the pilose rounded apices. Corollas 5–5.5 mm long, tubes 2.5–3 mm long, throats broadly campanulate, 0.5–0.7 mm long, teeth ovate, 1.3–1.5 mm long, glandular at the apex, the nerves borne well inward but parallel to the margins. Pappus bristles 60–70, ca. 6 mm long margins scabrid. Cypselae ca. 4.5 mm long, olivaceous, glandular.

Distribution and phenology. Endemic to Cuba; to ca. 200 m elevation; flowering December to April. Cited in Jamaica (followed by ?) in King and Robinson (1987), but no specimens seen from that island.

Representative specimen. **Cuba**. Cienfuegos. Limones, Soledad, near Cienfuegos, 26 Jan 1903, *Pringle 102* (F, GH, MO, US). Additional specimens cited in Holmes (1993).

This species has similarities with both *Mikania latifolia* and *M. trinitaria*. From the former, which has subcordate to shallowly cordate leaf bases, it is distinguished by its leaves with more cuneate bases. The glabrous, hexagonal stems with narrow wings are unusual, a condition shared with

the latter species. Characters given in the key adequate distinguish the two species and further discussion is presented under that species.

The corolla has deeply cleft teeth and a broadly campanulate throat. The veins of the teeth are more noticeably inward from the margins than any other species of the complex. Authorship of the name follows King and Robinson (1987).

12. **MIKANIA PARVIFLORA** (Aubl.) H. Karst., Deutsche Fl. 1061. 1880-1883. *Eupatorium parviflorum* Aubl., Pl. Guian. 2: 797, t. 315. 1775. *Eupatorium vincaefolium* Lam., Encycl. 2: 410. 1786 (nom. nov. for *Eupatorium parviflorum* Aubl.). *Willoughbya parviflora* (Aubl.) Kuntze, Revis. Gen. Pl. 1: 372. 1891. **TYPE**: **French Guiana**. Cayenne, *Aublet s.n.* (holotype: P?; isotype: BM!). Figure 17.

Eupatorium amarum Vahl., Symb. 3: 93. 1794. *Mikania amara* (Vahl) Willd., Sp. Pl. 3: 1744. 1803. **TYPE**: **Surinam**. *Rolander s.n.* (holotype: ?).

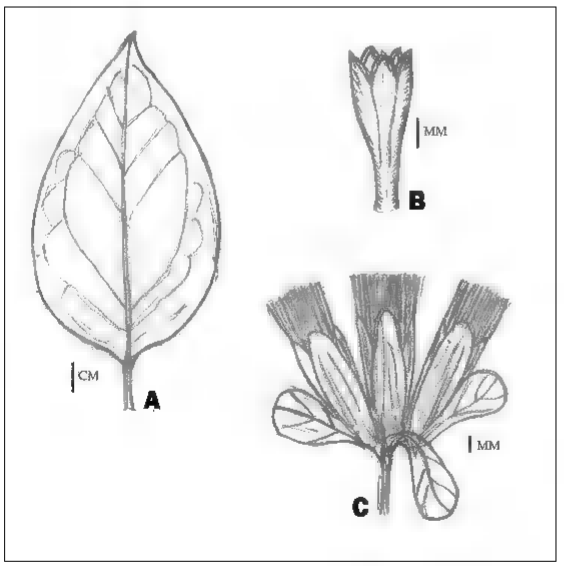
Mikania divaricata Poepp., Nov. Gen. Sp. Pl. 3: 53. 1845. *Willoughbya divaricata* (Poepp.) Kuntze, Revis. Gen. Pl. 1: 372. 1891. **TYPE**: **Brazil**. Prov. Alto Amazonas in marginibus sylvarum ad Ega, *Poeppig 2906* (holotype: B?).

Mikania stipitata Schultz-Bip. ex Miq., Stirp. Surinam Select. 191. 1851. **TYPE**: **Surinam**. *Hostman & Kappler 602* (holotype: U; isotypes: G-DC [Macbride neg. 16452], NY, P! [Macbride neg. 37526]).

Mikania cornifolia G. Don ex Baker, Fl. Bras. 6(2): 237. 1876 [nom. nud. in syn.]

Mikania loretensis B.L. Rob., Contr. Gray Herb. 64: 15. 1922. **TYPE**: **Peru**. Loreto, Maynas, Iquitos, *Ule 6238* (holotype: K; isotype: B (destroyed) [Macbride neg. 16452], GH!, photo & fragm.).

Mikania brooksii W.C. Holmes & McDaniel, Phytologia 41: 193. 1979. **TYPE**: **Peru**. Loreto, Prov. Maynas, Dtto. Iquitos, Río Momón, Santa Rosa, 3 Jan 1978, *McDaniel, Rimachi, & Brooks 21387* (holotype: IBE!).



Stems brown, terete, finely puberulent, smaller stems solid, pithy, the larger often fistulose; internodes to 20 cm or more. Leaves ovate, elliptic ovate, to oblong ovate, 6–15 × 3–11 cm, margins entire, apices acute to short acuminate, bases rounded to obtuse, texture somewhat chartaceous-coriaceous, upper surfaces glabrate to lightly puberulent, pinnate with 2 pairs of prominent nerves originating within the basal fifth of the blade, these arching forward and subparallel to the margins; upper surfaces glabrate to sparcely puberulous, prominently reticulate, lower surfaces prominently reticulate, finely puberulent, often glandular; petioles 0.5–2 cm, puberulent to pilose. Capitulescence ca. 10 cm in diameter; branchlets terete to irregularly angled. Capitula sessile to shortly pedunculate, 10 mm long; subinvolucral bracts spatulate-elliptic to obovate, somewhat "petiolate," 3–4 mm long, apices acute to rounded, bases cuneate, upper surfaces glabrate, lower surfaces puberulent, those of lateral capitula borne at the base of the phyllaries, those of medial capitula borne at the base of the involucre in sessile capitula but at the base of the peduncle in pedunculate capitula. Phyllaries oblong, 6–8 mm long, apices rounded to acutish, puberulent, the outer puberulent and slightly glandular, the inner glabrate. Corollas 4–4.5 mm long, white to lilac in color, tubes 1.5–1.8 mm long, throat cylindric to narrowly campanulate, 2.2–2.5 mm

long, teeth deltate, ca. 0.3 mm long, glandular. Pappus bristles white, ca. 50, 4–5 mm long, margins scabrid. Cypselae ca. 4 mm long, greenish to brownish.

Distribution and phenology. Southern Panama, northern South America to Peru, Bolivia, Brazil; flowering all year; sea level to about 600 m elevation. Figure 18.

Representative specimens. CENTRAL AMERICA. **Panama**. Darien, Capitulumwater of Río Tuquesa, ca. 2 km air distance from Continental Divide in vicinity of Tyler Kittredge, 25 Aug 1974, *Croat 27163* (US). SOUTH AMERICA. **Bolivia**. Santa Cruz, Velasco Prov. Parque Nacional Noel Kempff Mercado, Arroyo Las Londras, camino el Aserradero El Chore, 22 Jul 1996, *Arroyo 1350* (US). **Brazil**. Mato Grosso [Rondônia], Vida Nova, Porto Velho, Cuiabá-Rondônia, 20 Sep 1962, *Duarte 7321* (US). **Colombia**. Chocó, Río San Juan, Quebrada del Taparal, 30 May 1946, *Cuatrecasas 21474* (US). **Ecuador**. Zamora-Chinchipe, Nangaritza Canton, Pachicutza, Camino al Hito, 19 Oct 1991, *Palacios 8311 et a.l* (US). **French Guiana**. Sommet Tabulaire, 40 km SE de Saül, 27 Aug 1980, *Cremers 6468* (US). **Guyana**. Waini River, Northwest District, 3–18 Apr 1923, *De La Cruz 3827* (US). **Peru**. Loreto, Mishuyacu, near Iquitos, Jan 1930, *Klug 837* (US). **Surinam**. Upper slopes of Juliana Top, 15 km N of Lucie River, 18 Aug 1963, *Irwin et al. 54890* (US). **Venezuela**. Terr. Fed. Amazonas, Solano on Río Casiquiare, 19 km NE of San Carlos de Río Negro, 24 Nov 1977, *Liesner 3824* (US).

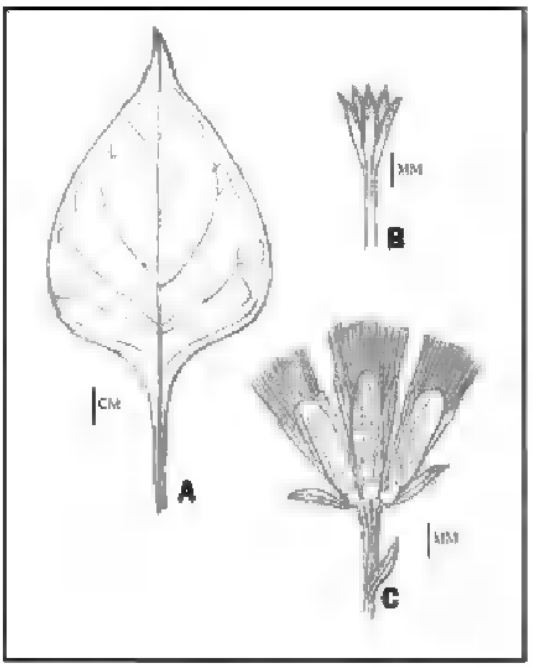
Mikania parviflora is nomenclatorially the oldest name in this complex and was used by Robinson (1922) to refer to the group, hence the current use of the name. However, it is clear that he misapplied the name *M. parviflora* to a species (probably *M. trinitaria*) having corolla teeth greater in length than the length of the throat (see also Robinson 1922). This misapplication of the name has seemingly been followed by and led to errors by Barroso (1959) and others in delineating species of this complex. *Mikania parviflora* is characterized by its ovate, elliptic-ovate, to oblong-ovate leaves with pinnate venation. Two pairs of secondary nerves originate within the basal one-fifth of the blade. The subinvolucral bracts are distinctive in being elliptic-spatulate to obovate with a gradually narrowed base causing the structure to appear petiolate. Corollas are often lilac in color and have very short deltate corolla teeth.

Mikania parviflora is more widespread in distribution than any member of the group other than *M. guaco*.

13. **MIKANIA SPECIOSA** DC., Prodr. 5: 196. 1836. TYPE: **Peru**. *Haenke s.n.* (G-DC!). Figure 19.

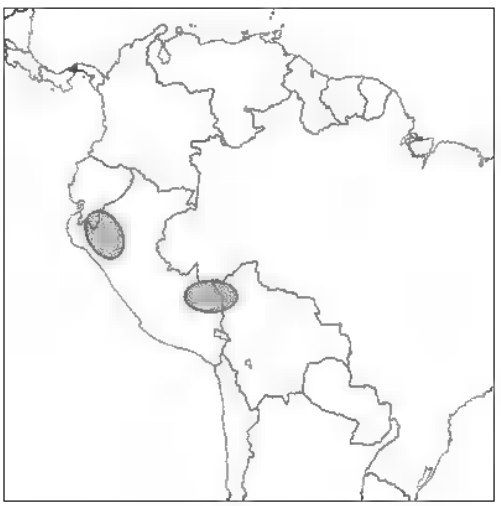
Mikania attenuata DC., Prodr. 5: 195. 1836. TYPE: **Peru**. "Montibus Huanacocensis," *Haenke s.n.* (holotype: G-DC!).

Willoughbya hieronymi Rusby, Bull. New York Bot. Garden 4: 383. 1907. TYPE: **Bolivia**. Coripati, Yungas, 28 Apr 1894, *Bang 2169* (holotype: NY! isotypes: GH!, MO!, US!).



Stems terete, glabrate to puberulent, younger stems solid, pithy, the older pithy or more often fistulose; internodes to ca. 16 cm or more. Leaves broadly ovate, 8–15 × 3.5–11 cm, margins entire, apices acute, bases rounded, cuneately decurrent upon petiole at insertion, pinnately nerved with 2–3 pairs of secondary nerves originating within the basal third of the blade, reticulate; upper surfaces generally scabrid, lower surfaces tomentellous; petioles 3–6 cm long, occasionally prominently winged. Capitulescence 3–16 cm or more in diameter and 4–8 cm tall; branchlets irregularly terete, puberulent. Capitula 10–12 mm long; exterior bracts linear-lanceolate, ca. 3 mm long, puberulent, those of lateral capitula borne at the base of the involucre, those of the median capitulum borne ca. 5 mm below the involucre. Phyllaries oblong, 7–8 mm long, apices rounded to obtuse, puberulent, glandular, the outer pair puberulent, glandular, the inner pair glabrate. Corollas 5–6 mm long, purplish, tubes 2.5–3 mm long, throats ca. 0.7 mm long, the teeth oblong, ca. 1.3 mm long, the nerves marginal. Pappus bristles ca. 65, 5–6 mm long, not thickened at the tips, margins scabrid. Cypselae ca. 3.5 mm long, dark grayish or grayish-green, glabrate to puberulent.

Distribution and phenology. Andes Mountains of Bolivia, Peru, and Ecuador; 1200–2400 m elevation; flowering April to August. Figure 20.



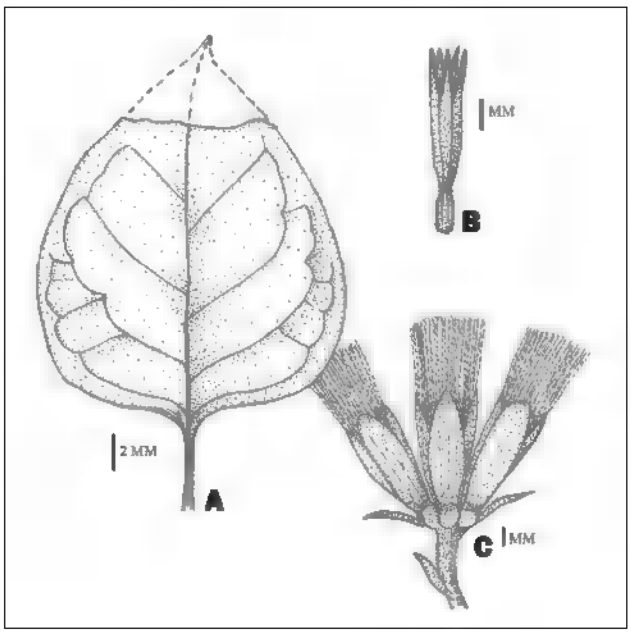
Representative specimens. **Bolivia**. Coripati, Yungas, 28 Apr 1894, *Bang 2169* (US). **Ecuador**. Zamora-Chinchipi, area of ECSP Research Station ca. 30 km away from the city of Loja on highway toward Zamora, 1800 m, 12 Dec 2000, *Matezki 300* (US). **Peru**. Amazonas, Chachapoyas, Quebrada Molina 5 km below Chachapoyas, 5 Jun 1962, *Wurdack 770* (F, US).

Mikania speciosa is very similar to *Mikania guaco* in habit, leaf shape, nature of the bases, and scabrid upper surfaces. It is best distinguished by its corolla teeth which are about 3× the length of the throat.

Mikania attenuata is included as a synonym of *Mikania speciosa*. Until Robinson and Holmes (2007), the name *M. attenuata* has been treated a synonym of *M. guaco*, based upon B.L. Robinson's (1922a) evalulation: "*M. attenuata* DC., here doubtfully referred to this species [i.e., *M. guaco*], has been studied chiefly from a photograph of the type-material … From this it appears that the habitual correspondence is close and the original diagnosis fails to show any very significant differences except the smoothness of the leaves, which may in the brevity of the description have been somewhat overstated." Examination of the holotype at G-DC showed that the corolla teeth are

significantly longer than the throat, thus it cannot be *M. guaco*, a species marked by its short corolla teeth. However, neither name (*M. speciosa* or *M. attenuata*), both proposed by de Candolle (1836), has date priority. In order to promote name stability, the name *M. speciosa* was selected for the species (Robinson & Holmes 2008) rather than resurrect the name *M. attenuata*, which has long been buried in the synonymy of *M. guaco*.

14. **MIKANIA TAFALLANA** Kunth, Nov. Gen. Sp. 4: 107. Ed. Folio. 1818. *Mikania tafallae* Spreng., Syst. Veg. Fl. Peruv. Chil. 3: 422. 1826. *Willoughbya tafallana* (H.B.K.) Kuntze, Rev. Gen. 1. 373. 1891. **TYPE**: **Ecuador**. Ad ripas fluminis Daule prope Guayaquil, *Tafalla s.n.* (holotype: P; isotype: GH!). Figure 21.



Stems terete [to hexagonal?], slightly puberulent to asperous. Leaves broadly elliptic to elliptic-ovate to rotund, to 9–22 × 6–4 cm, apices acute, margins entire, narrowly revolute, bases rounded to an abrupt cuneation at the petioles, venation pinnate, secondary nerves more or less evenly disposed over the length of the blade, upper surfaces asperous, lower surfaces puberulent (particularly the veins), prominently reticulate; petioles ca. 1.2–4 cm long, glabrate. Capitulescence corymbiform, ca. 4–15 cm tall and 7–20 cm wide. Capitula ca. 12 mm long; subinvolucral bracts linear, 2–2.5 mm long, those of the lateral capitula borne at the very base of the phyllaries, those of the medial capitula borne about midway down the peduncle. Phyllaries elliptic-oblong, ca. 7 mm long, surfaces 5 or more nerved, apices rounded, pubescent, the outer pair puberulent, glandular, the inner glabrate to sparingly puberulent. Corollas ca. 7 mm long, tubes 2–2.5 mm, throats cylindric, 3–3.3 mm long, teeth laceolate, ca. 1.3 mm long. Pappus bristles ca. 7 mm long, 60–64, margins scabrid. Cypselae ca. 4 mm long, smooth.

Distribution and phenology. Endemic to the Pacific slopes of western Ecuador; to about 600 m; flowering all year?

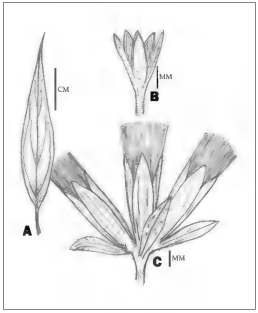
Additional specimens. **Ecuador**. Esmeraldas, Quininde, Bilsa Biological Station, Montañas de Mache, 35 km W of Quininde, 5 km W of Santa Isabella, 0° 21′ N, 79° 44′ W, 400–600 m, 8 Dec 1994, *Pitman & Bass 1054* (MO, US); Manabi, Jama, 28 km S of Pedernales, 3.5 km SW of town of Camarones, 28 Nov 1999, *Delinks 515* (MO).

In his treatment of the *Mikania* of Ecuador, Robinson (1922a) compared *M. tafallana* with "the little understood [at the time] *M. parviflora* of French Guiana." His statement "in *M. parviflora* the [corolla] teeth are longer than the throat," when coupled with the stated distribution (French Guiana), suggests *M. trinitaria* instead, a species with the corolla teeth being longer in length than the throat. *Mikania parviflora* has very short corolla teeth, generally one-fourth or less as long as the throat (see above). The same error is in Robinsons's (1922b) key to the members of the *M. parviflora* group. More accurately, *M. tafallana* closely resembles the very common and well-known *Mikania*

guaco, especially in leaf characteristics. In particular this includes general leaf shape, the roughened nature of the upper leaf surfaces, and the short cuneation at the leaf bases. Careful observation shows the leaves to be more rotund, have but a short cuneation at the base, and have pinnate venation with the secondary nerves more evenly disposed over the length of the blade. *Mikania guaco* has more ovate-oval leaves, pinnate venation with the secondary nerves originating in a rather congested manner in the basal fourth of the blade, and exceedingly prominent cuneate-decurrent leaf bases. Reliance of these traits for distinguishing the two species would be tentative at best. However, a far more precise character, the nature of the corolla teeth, can be used to effect separation. *Mikania tafallana* has lanceolate corolla teeth that are about one-third to one-half the length of the throat while *M. guaco* has broadly deltate corolla teeth that are about one-fifth or less the length of the throat.

Before treatment by Robinson and Holmes (2008), the species was previously known only from the type material.

15. **MIKANIA TRIMERIA** W.C. Holmes & McDaniel, Phytologia 50: 8. 1981. **TYPE**: **Colombia**. Amazonas-Vaupes, Río Apaporis, raudal Yayacopi (La Playa) and vicinity, 0° 5' S, 70° 30' W, ca. 800 ft., 15 Apr 1952, *Schultes & I. Cabrera 16221* (holotype: US!). Figure 22.



Stems terete, striate, glabrate; sparsely puberulent at the nodes and on younger parts of the stem; internodes 2.5–5.5 cm long. Leaves verticillate (3 per node), lanceolate-linear, 2.5–4 × 0.4–0.7 cm, pinnately nerved, apices acuminate, margins entire, bases attenuate, upper surfaces glabrate, the major nerves obscurely impressed, lower surfaces densely puberulent, the major nerves exserted from the surface, prominent, veinlets obscured; petioles 3–4 mm long, puberulent. Capitulescence ca. 3.5 cm tall and 4.5 cm in diameter. Capitula 7–9 mm long; subinvolucral bracts elliptic-obovate, 3–4 mm long, puberulent, apices acute; borne at the very base of the involucre in both lateral and medial capitula. Phyllaries lance-ovate to elliptic ovate, 5–6 mm long, the outer sparingly puberulent, striate, apices acute, puberulent, the inner glabrate, striate, the apices obtuse, puberulent. Corollas 4–4.5 mm long, tubes ca. 1.2–1.5 mm, throats funnelform, ca. 1.0 mm long, teeth lanceolate, ca. 2 mm long, sparingly glandular, the summit of the inner surfaces hirsute, veins marginal; bases slightly expanded. Pappus bristles white, 40–45, 5–6 mm long, margins scabrid. Cypselae ca. 2.8 mm long, puberulent.

Distribution and phenology. Known only from the type collection in Colombia; flowering in April.

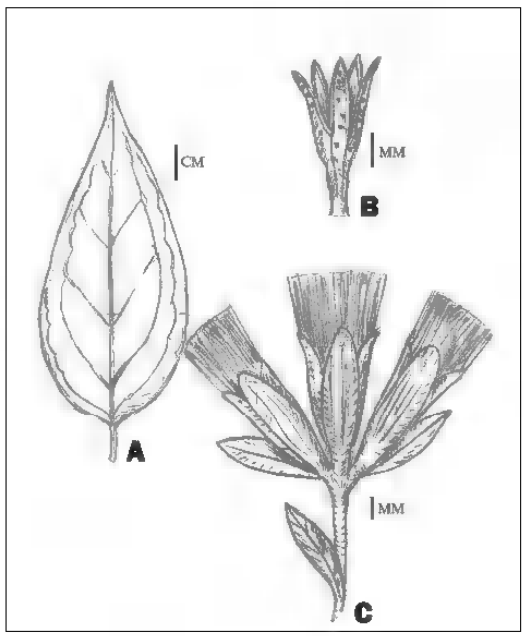
This species is well-marked by its whorled lanceolate-linear leaves. The capitulescence branches trichotomously, which seems to be a continuation of the leaf arrangement, rather than dichotomously as do the other members of the group.

The corollas indicate near affinity with *Mikania trinitaria*, which may be distinguished by its hexagonal stems, corolla teeth with nerves borne inward but parallel to the margins, and opposite, ovate leaves.

16. **MIKANIA TRINITARIA** DC., Prodr. 5: 194. 1836. *Willoughbya trinitaria* (DC.) Kuntze, Revis. Gen. Pl. 1: 373. 1891. **TYPE**: **Trinidad**. *Sieber s.n.* (holotype: G-DC!; isotype: BM!). A presumed isotype at BM is labeled as *Sieber 182*, while the holotype at G-DC is unnumbered. Figure 23.

Mikania santamensis V.M. Badillo, Bol. Soc. Venez. Ci. Nat. 9: 135. 1944. **TYPE**: **Venezuela**. Anzoátegui. Morichal del baño, Río Tigre, 26 Dec 1940, *Pittier 14626* (holotype: VEN!; isotype: F, photo US!).

Mikania capayensis V.M. Badillo, Bol. Soc. Venez. Ci. Nat. 10: 304. 1946. **TYPE**: **Venezuela**. Miranda, Alrededores Capaya, 100-400 m, 3 Apr 1944, *Badillo 441* (holotype: VEN!).



Stems hexagonal, the angles finely winged, the larger glabrate and fistulose, the younger solid, often puberulent; internodes 3–15 cm or more long. Leaves ovate, 5–15 × 3–6 cm, apices acute to acuminate, margins entire, bases rounded to obtuse to occasionally shortly acuminate, pinnately nerved with 2 pairs of more prominent secondary nerves originating within the basal fourth of the blade, upper surfaces glabrous, lower surfaces finely puberulent, glandular; petioles 1–3 cm long, glabrate to puberulent. Capitulescence corymbiform, to ca. 15 cm tall and 15 cm in diameter, dense to open; capitula occasionally borne on peduncles 1–3 mm long. Capitula 10–12 mm long; subinvolucral bracts linear to ovate, 2–4 mm long, the abaxial surfaces puberulent, the adaxial surfaces glabrate; those of the lateral pair of capitula borne at the very base of the involucre, while those of the medial capitula may be borne from the very base of the involucre to the base of the peduncle supporting the cluster of capitula. Phyllaries oblong to elliptic-oblong, apices rounded, puberulent, the outer pair puberulent, glandular, the inner glabrate. Corollas 5–5.5 mm long, glandular, tubes 2–3 mm long, throats campanulate to funnelform, 0.8–1 mm long, teeth lanceolate, ca. 2 mm long, glandular, nerves borne inward but parallel to the margins. Pappus bristles white, ca. 6 mm long, 35–40, margins scabrid. Cypselae ca. 3.5–5 mm long, glandular.

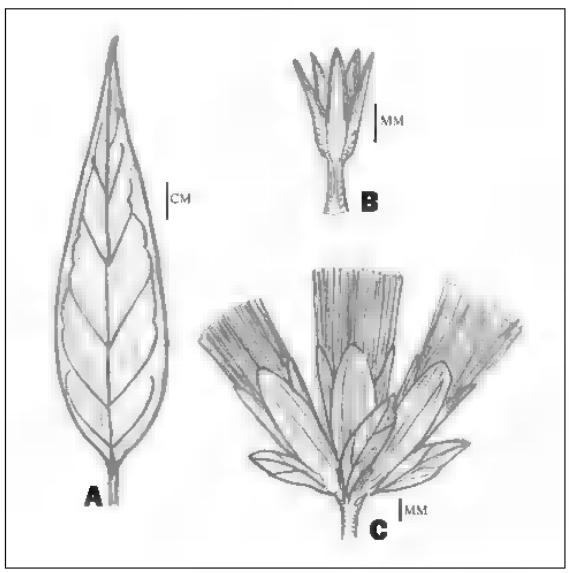
Distribution and phenology. Northern South America from Colombia to the Guianas and Trinidad, Amazonas and Pará, Brazil, also the Lesser Antilles; 50-1700 m; flowering mostly February to March. Figure 24.

Representative specimens. LESSER ANTILLES. **Montserrat**. 12 Feb 1907, *Shafer 518* (US). **St. Vincent**. Calvary, Jan 1890, *Eggers 6819* (US). **Trinidad and Tobago**. Trinidad. Piarco Savann, south of Arouca, 27 Feb 1920, *Britton 111 et al.* (US). SOUTH AMERICA. **Brazil**. Pará, Jarí, margem do Rio Jarí, entre Monte Dourado e São Militão, 28 Apr 1969, *Silva 1939* (US). **Colombia**. Meta. Mpio. La Macarena, Reserva de La Macarena, 20 km NO en la via a Conejos, 7 Aug 1988, *Callejas & Marulanda 6970* (US). **French Guiana**. Plaine de Kaw, crique Angélique, 13

Apr 1984, *Granville 6804* (P, US). **Guyana**. Pomeroon-Supenaam Region, Canal near Red Lock on way to Copoey Lake, 5 Mar 1991, *McDowell 4109 et al.* (US). **Surinam**. Without further location or date, *Coulon 234* (MO). **Venezuela**. Lara, Macuto, *Saer 163* (US).

Mikania trinitaria is characterized by its hexagonal stems and deeply cut corolla teeth with the nerves being borne inward from the margins. The latter condition is not always readily apparent and may result in difficulty in distinguishing *M. trinitaria* from *M. vaupesensis,* which is discussed under that species. *Mikania trinitaria* appears closely related to *M. oopetala* of Cuba, which also exhibits the traits mentioned. However, *M. oopetala* has the corolla teeth even more deeply cut and the throat more broadly expanded. Others differences are cited in the key to species.

17. **MIKANIA VAUPESENSIS** W.C. Holmes & McDaniel, Phytologia 50: 9. 1981. **TYPE**: **Colombia**. Vaupes. Río, near Mitu, 13 Nov 1952, *Schultes & I. Cabrera 18422* (holotype: GH). Figure 25.



Stems terete to somewhat hexagonal, glabrate, striate; internodes to 20 cm or more long. Leaves lanceolate to lance-ovate, 5–26 × 1.8–5.5 cm, apices acuminate, margins entire, bases obtuse to acute to acuminate, pinnately nerved with the secondary nerves rather evenly disposed over the length of the blade, upper surfaces glabrate, lower surfaces puberulent, glandular, veinlets reticulate, prominent; petioles 1–1.8 cm long, glabrate to puberulent. Capitulescence 3.5–10 cm tall and 4–10 cm wide, branchlets puberulent; capitula sessile or nearly sessile. Capitula 9–11 mm long; subinvolucral bracts lance-ovate to ovate to ob-ovate, 3–5.5 mm long, apices acute, adaxial surfaces glabrate, abaxial surfaces puberulent, midvein prominent; those of lateral and medial heads borne at the very base of the involucre. Phyllaries oblong to narrowly ovate, 4–7 mm long, the outer puberuent, apices rounded to obtuse, puberulent, the inner glabrate, apices rounded to obtuse, puberulent. Corollas white to pinkish, ca. 4–4.5 mm long, tubes 1.5–2 mm long, throats campanulate, ca. 0.5–1 mm long, teeth lanceolate, 2–2.5 mm long, the veins marginal; sparingly glandular near the apex. Pappus bristles, white, 50–60, 5–5.5 mm long, margins scabrid. Cypselae light green, ca. 5 mm long.

Distribution and phenology. Amazon-Vaupes region of Colombia; 200-230 m elevation; flowering August-September.

Additional specimen. **Colombia**. Amazonas-Vaupes. Río Apaporís, Raudal Yayacopi (La Playa) and vicinity, 18 Aug 1952, *Schultes & Cabrera 16957* (GH).

This species is characterized by its narrow lanceolate to lance-ovate leaves with acuminate apices and bases. Also, the leaves are distinctly pinnate with the secondary nerves evenly spread over the blade. In many respects, the species is similar to the more widespread *Mikania trinitaria*. That species has secondary nerves that originate within the basal one-fourth of the blade. Corolla teeth of *M. vaupesensis* are longer than the length of the throat, as they are in *M. trinitaria*, but the nerves are

borne at the margins, whereas they are borne inward from the margins in *M. trinitaria*, a trait sometimes difficult to discern in some specimens.

ACKNOWLEDGEMENTS

This paper is based upon studies conducted during the summer of 2000 at the National Museum of Natural History (US) of the Smithsonian Institution and was made possible through a Senior Research Fellowship grant to the author. Many of the ideas expressed here are the result of conferring with Harold Robinson, who also served as my host during the fellowship. Other financial support was received from the College of Arts and Sciences, Baylor University, in the award of a Summer Research Sabbatical, and by the Baylor University Research Committee.

Individuals who provided information, advice, specimens, or other assistance included Michael Dillon of F, John Pruski of MO, and Margie Knowles, former technical assistant of Harold Robinson. Darrell Vodopich and Jeffrey Mink, both of Baylor University, provided computer assistance. Gina Gollub, a student herbarium worker at BAYLU, assisted with the production of the maps and illustrations, and Robert Baldridge, a colleague here at Baylor University, made suggestions on manuscript presentation. Kristin Paredez, a Baylor University undergraduate, helped with preparation the layout of the text and illustrations.

Finally, I am sincerely indebted to the herbaria mentioned within for use of their specimens and to Guy Nesom, editor of Phytoneuron.

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Hagenbuch, K.W. and D.E. Lemke. 2015. Grasses of the Texas Hill Country: Vegetative key and descriptions. Phytoneuron 2015-4: 1–93. Published 7 January 2015. ISSN 2153 733X

GRASSES OF THE TEXAS HILL COUNTRY: VEGETATIVE KEY AND DESCRIPTIONS

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ABSTRACT

A key and a set of descriptions, based solely on vegetative characteristics, is provided for the identification of 66 genera and 160 grass species, both native and naturalized, of the Texas Hill Country. The principal characters used (features of longevity, growth form, roots, rhizomes and stolons, culms, leaf sheaths, collars, auricles, ligules, leaf blades, vernation, vestiture, and habitat) are discussed and illustrated. This treatment should prove useful at times when reproductive material is not available.

Because of its size and variation in environmental conditions, Texas provides habitat for well over 700 species of grasses (Shaw 2012). For identification purposes, the works of Correll and Johnston (1970); Gould (1975) and, more recently, Shaw (2012) treat Texas grasses in their entirety. In addition to these comprehensive works, regional taxonomic treatments have been done for the grasses of the Cross Timbers and Prairies (Hignight et al. 1988), the South Texas Brush Country (Lonard 1993; Everitt et al. 2011), the Gulf Prairies and Marshes (Hatch et al. 1999), and the Trans-Pecos (Powell 1994) natural regions. In these, as well as in numerous other manuals and keys, accurate identification of grass species depends on the availability of reproductive material. No current treatment provides any useful measures for identifying Texas grasses by vegetative characters. Identification of grass species, however, must often be attempted at times when flowers or fruits are unavailable, i.e., when the specimens were collected prior to the flowering/fruiting period or the flowers or fruits were lost to mowing or grazing.

The development of a reliable system to accurately identify grasses in the vegetative state has been attempted, but only in a limited number of works. Most notable are Hitchcock's treatment of the grasses of the Pacific Northwest (1969), Sutherland's key to Nebraska grasses (1975), and Barnard and Potter's work on the grasses of New Mexico (1985). The small number of additional, less comprehensive works includes a vegetative key for Kansas grasses (Copple & Aldous 1932), a similar treatment for Arizona range grasses (Copple & Pase 1967), and Sexton's vegetative treatment of central Texas grasses (2000). This latter work includes vegetative descriptions for 31 species; however, it does not include a key and covers a very limited geographic area.

The treatment presented here presents a comprehensive key and set of descriptions for the identification of central Texas grasses based exclusively on vegetative characteristics. It includes the grass species that occur in the Texas Hill Country or Balcones Canyonlands (Figure 1), a subregion of

the Edwards Plateau natural region of Texas. The work allows for the identification of grass species at such times when a key based on reproductive material is useless.

This treatment will be an indispensable tool for botanists, ecologists, wildlife managers, and environmental consultants. It will also serve as the framework for future work on vegetative keys for the grasses of the other natural regions of Texas.

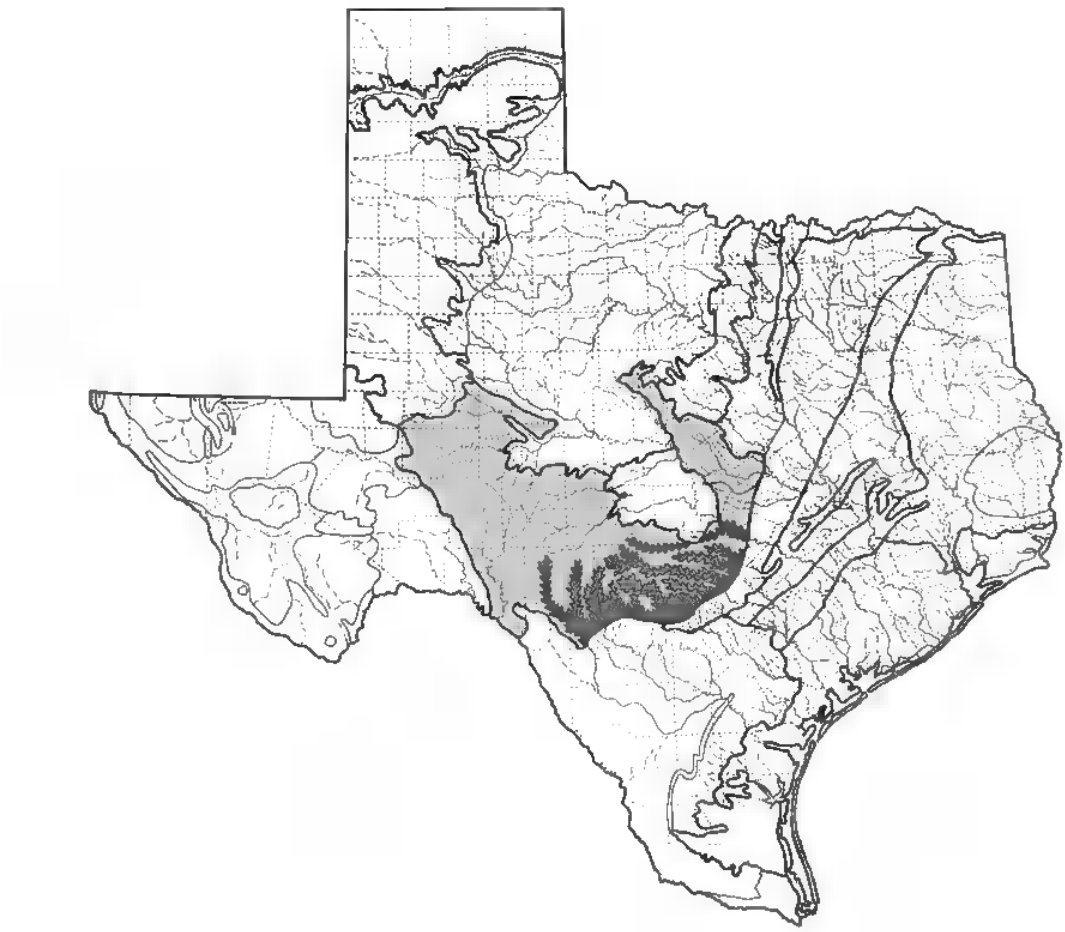
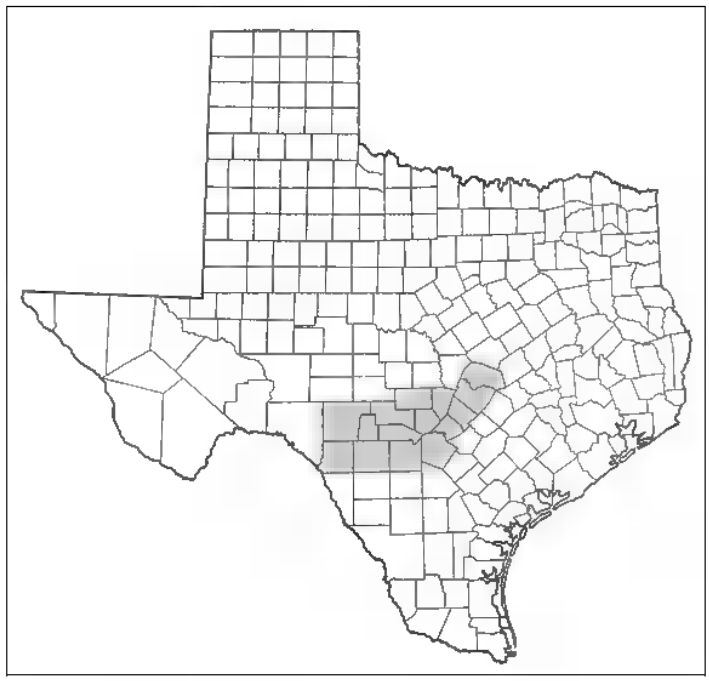


Figure 1. The Balcones Canyonlands subregion (dark gray) within the Edwards Plateau Natural Region (gray). Redrawn from LBJ School of Public Affairs (1978).

Materials and Methods

A list of grass species occurring within the Texas Hill Country was compiled from the county distribution maps in Turner et al. (2003) and Shaw (2012). Species reported from the following counties were initially included: Bandera, Bexar, Blanco, Comal, Edwards, Gillespie, Hays, Kendall, Kerr, Kinney, Medina, Real, Travis, Uvalde, and Williamson (Figure 2). Since many of these counties lie only partially in the Hill Country, label data were used to exclude species that were not collected on the Edwards Plateau. The resulting list included 66 genera and 160 species of native and naturalized grasses. A complete list of the species treated, arranged by subfamily and tribe, is included as Appendix A, and a list of the specimens examined is included as Appendix B. Nomenclature follows Barkworth et al. (2007).



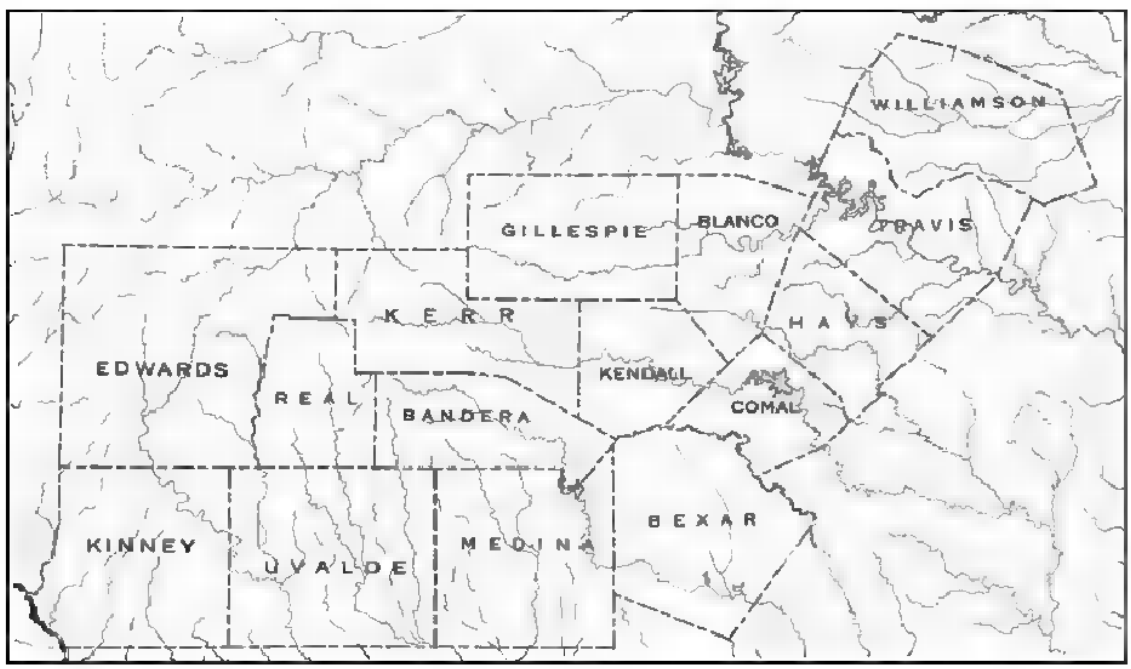


Figure 2. Counties partially or wholly included in the Texas Hill Country.

Both living plants and herbarium specimens were examined to collect descriptive data on vegetative morphology, with most of the descriptive work based on specimens from throughout the Texas range of each species housed at SWT, TAES and TEX-LL. The keys of Hitchcock (1969),

Sutherland (1975), and Barnard and Potter (1984) were consulted to aid in the selection of important vegetative characteristics. When information could not be discerned from the available specimens, characters were obtained from the works of Silveus (1933), Correll and Johnston (1970), Gould (1975), and Shaw (2012). A discussion of the principal characters employed in the construction of the key is presented below. Included are descriptions and general information on the characteristics that appear in the key and the species descriptions. The illustrations provided at the end of this section are general representations designed to assist the user. They are not drawn to scale and do not represent any particular species. An overview of basic grass structure is provided in Figure 3.

Longevity. Plant longevity is either perennial, persisting for more than a single year, or annual, completing the growth cycle within a single year. Perennial grasses typically exhibit evidence of the previous year's growth near the base and often have an extensive, well-developed root system that may include rhizomes. Annual grasses lack the remains of previous year's growth, have a shallow root system that is easily pulled up, and are never rhizomatous.

Growth Form. Growth form is described as solitary, cespitose, or mat-forming (Figure 4). Solitary plants can also occur in small clumps consisting of a few individual plants. Cespitose grasses are clusters or a tuft of shoots arising either directly from a single crown or from the nodes of often short or reduced rhizomes or stolons. Mat-forming grasses or sod-forming grasses entangle the uppermost layer of soil with rhizomes or stolons.

Roots. The rootstock of a grass plant is a fibrous network of slender, irregularly branched, adventitious roots. The roots develop from the lower nodes of the culm and quickly replace the short-lived primary root system.

Rhizomes and Stolons. Rhizomes and stolons are horizontal stems involved in vegetative reproduction. Both structures consist of internodes, nodes, and reduced leaves. The nodes of rhizomes and stolons typically give rise to roots and new shoots. Rhizomes run underground, often produce scale-like leaves, and are typically stout and usually obvious when the grass is removed from the soil. Stolons run along the top of the soil, lack scale-like leaves, and do not require excavation to observe. In some species where rhizomes and stolons are absent, the plant arises from a slightly swollen, hard, and often knotty base (e.g. *Digitaria insularis* and *Muhlenbergia porteri*).

Culms. Culms, the jointed stems of a grass plant, are composed of internodes and nodes. Culms are described as erect or ascending, geniculate, decumbent, or prostrate according to their growth habit (Figure 5). Geniculate culms are bent abruptly at a node, resembling a knee or elbow. Decumbent culms lie on the ground but have ascending tips. Prostrate culms lie flat on the ground. Culm internodes are typically cylindrical and elongate. Culm nodes are usually swollen.

Sheaths. The sheath is the lower portion of the grass leaf and encloses the culm or a developing leaf. Sheaths are classified as rounded or compressed (Figure 6). Compressed sheaths show some degree of longitudinal flattening. Compressed or rounded sheaths may or may not be keeled. Keeled sheaths have a prominent lateral ridge along the midnerve. Sheaths are also classified with respect to their margins as distinct or closed (Figure 6). Distinct sheath margins are not connate and are further classified as open or overlapping. Distinct, open sheath margins do not completely enclose the culm. The effect is an observable gap between the margins. Distinct, overlapping sheath margins completely enclose the culm such that one margin overlies the other. Closed sheath margins are connate resulting in a sheath that is tubular. The degree of closure varies and often extends the entire length of the sheath. Closed sheaths often tear or split lengthwise upon drying making them appear open but leaving a somewhat conspicuous ragged margin.

Collars. The collar is a band of tissue on the abaxial side of a grass leaf at the junction of the sheath and blade and is typically differentiated by color or texture. Collars are classified as continuous or divided and horizontal or oblique (Figure 7). Continuous collars appear as an uninterrupted band. Divided collars are interrupted by the midrib. Horizontal collars are perpendicular to the midnerve. Oblique collars are higher on one side. In some species (e.g., *Glyceria striata*) the collar is barely visible or cannot be differentiated by color or texture, and it is consequently described as inconspicuous.

Auricles. Auricles are thin, membranous extensions of the collar margins (Figure 7). Careful observations should be made to avoid mistaking auricles for ligule lobes, which are lateral extensions of the ligule that are typically erect. Auricles may or may not clasp the culm, are very fragile, and wither with age. Care should be taken when inspecting them, particularly on dried specimens.

Ligules. The ligule is a small appendage of the leaf sheath on the adaxial side of a grass leaf at the junction of the sheath and blade. Ligules may be membranous or a fringe of hairs. The shape of the ligule apex and the ligule margin can be used to further classify membranous ligules. Ligule apex shapes are acute, obtuse or truncate (Figure 8). Ligule margins can be entire, erose, lacerate, ciliate, or ciliolate (Figure 8). Ligules may also be decurrent and adnate with the sheath margins (Figure 8). Caution should be used when inspecting membranous ligules on dried specimens. Membranous ligules tend to shrivel and deform with age or drying, which can result in an inaccurate determination when using the key. They are best observed on fresh specimens.

Blades. The blade is the flattened, expanded portion of the leaf above the sheath. Blades are classified by the following characteristics: shape, outline in cross section, texture, color, apex shape, margin features, and surface features. Blade outline shapes are linear, lanceolate, and filiform (Figure 9). Cross sectional outlines can be plane (flat), U-shaped, V-shaped, conduplicate, convolute, or involute (Figure 9). Conduplicate blades are folded together lengthwise with the adaxial surface within. Convolute blades are rolled up longitudinally with one margin outside, the other inside and the adaxial surface within. Involute blades have the margins rolled inward toward the adaxial surface. Texture is either firm or flaccid. Color is typically green or glaucous. Occasionally some type of distinct banding pattern or blotching may be present (e.g., *Echinochloa colona*). Apices can be obtuse, acute, acuminate, attenuate, mucronate, or prow-shaped (Figure 10). Blade margins can be entire, barbed, serrate, serrulate, undulate, or exhibit some type of pubescence (Figure 10). The blade margins on some species (e.g., *Erioneuron pilosum*) have a cartilaginous texture and appear whitish in color. The blades of some species (e.g., *Poa annua*) exhibit median lines. Median lines are small, light-colored lines or grooves that run the length of the blade parallel to the midnerve on the adaxial surface (Figure 11). The midnerve on the blades of some species is often conspicuous abaxially. This is due to either its protrusion, a color differentiation (e.g., *Eragrostis cilianensis*), or the presence of vestiture (e.g., *Leersia oryzoides*).

Vernation. Vernation, the cross sectional appearance of the blade as it is developing, is either folded or rolled in grass plants (Figure 11). In folded vernation, the young leaf is conduplicate. In rolled vernation, it is convolute. Vernation is best observed in an innovation, the basal shoot of a perennial grass plant. Slicing through a young sheath just below the collar and observing the enclosed blade can also aid in determining vernation.

Vestiture. Vestiture is the collective term for the epidermal covering of a plant. Vestitures include, but are not limited to pubescence (the general term for any degree of plant hairiness, but as used here the term "pubescent" describes a particular type of vestiture). Vestiture can be present on culms, sheaths, collars, and blades. For the purposes of this key, vestiture is classified as follows:

hirsute, or covered with long, straight, moderately stiff hairs; hispid, or covered with long, straight, stiff, bristle-like hairs; pilose, or covered with long, straight, soft hairs; pubescent, or covered with fine, short, soft hairs; puberulent, or minutely pubescent; scabrous, or rough to the touch due to short, stiff hairs — the most common vestiture in grass plants; strigose, or covered with short, bent, stiff, sharp hairs; tomentose, or covered with short, densely matted, soft hairs; and villous, or covered with long, curved or wavy, soft hairs (Figure 12). The hairs present on some species (e.g., the sheaths of *Leptochloa panicea*) are papilllose. Papillose hairs arise from papillae, minute, nipple-shaped projections on the epidermis (Figure 12). Surfaces without hairs are referred to as glabrous.

Habitat. The habitat describes the environmental conditions in which the plant exists. This can include the topography of an area, intensity of sunlight, available moisture, soil types, and other features. Although not a vegetative characteristic, habitat information can be an important trait when making a final determination.

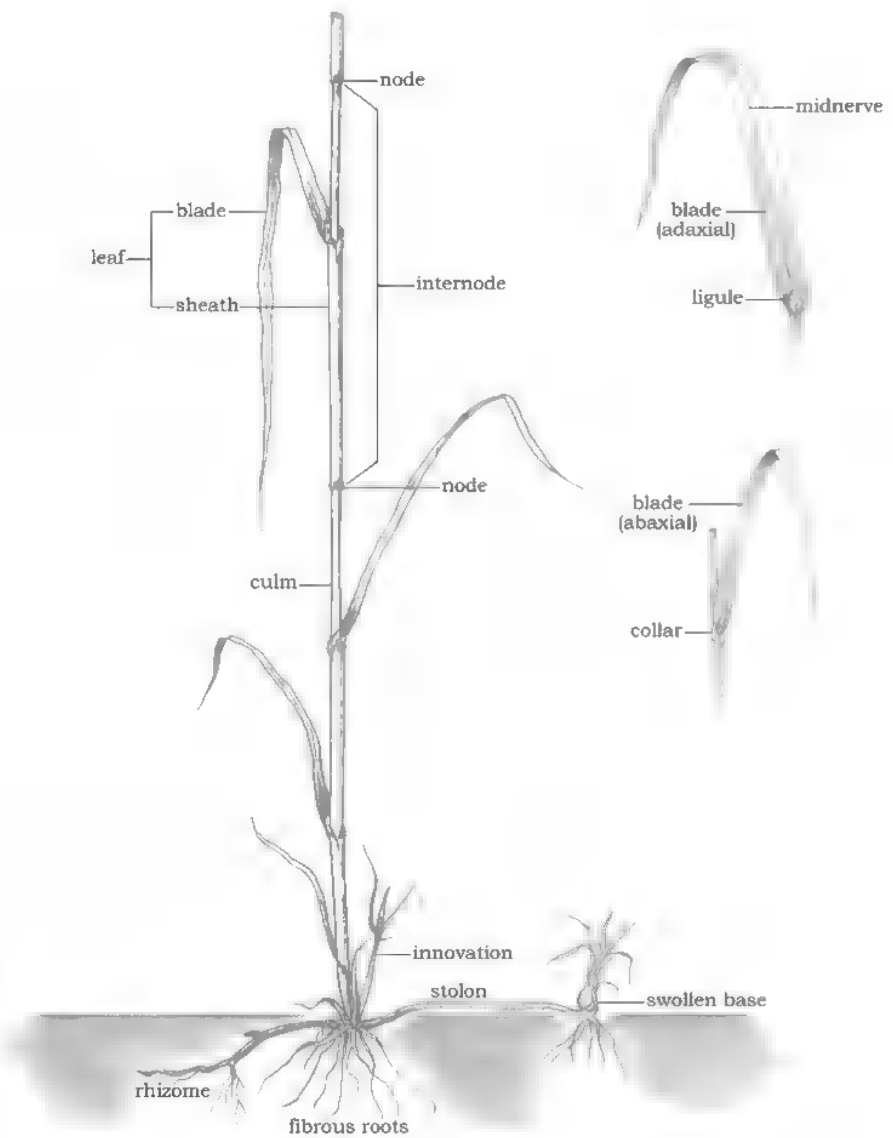


Figure 3. Vegetative morphology of the grass plant. Redrawn from Hitchcock (1969).

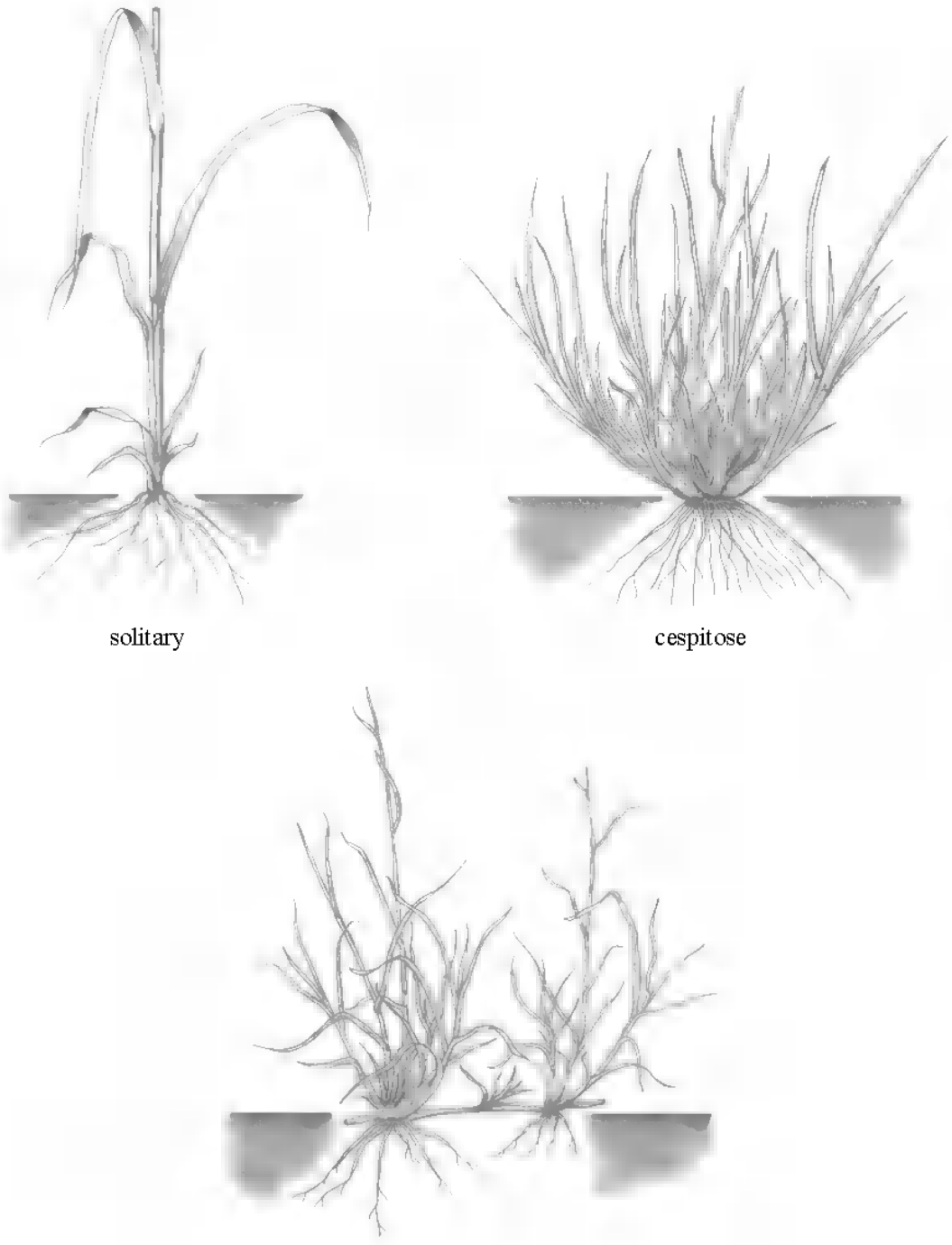


Figure 4. Growth forms of the grass plant. Redrawn from Hitchcock (1969).

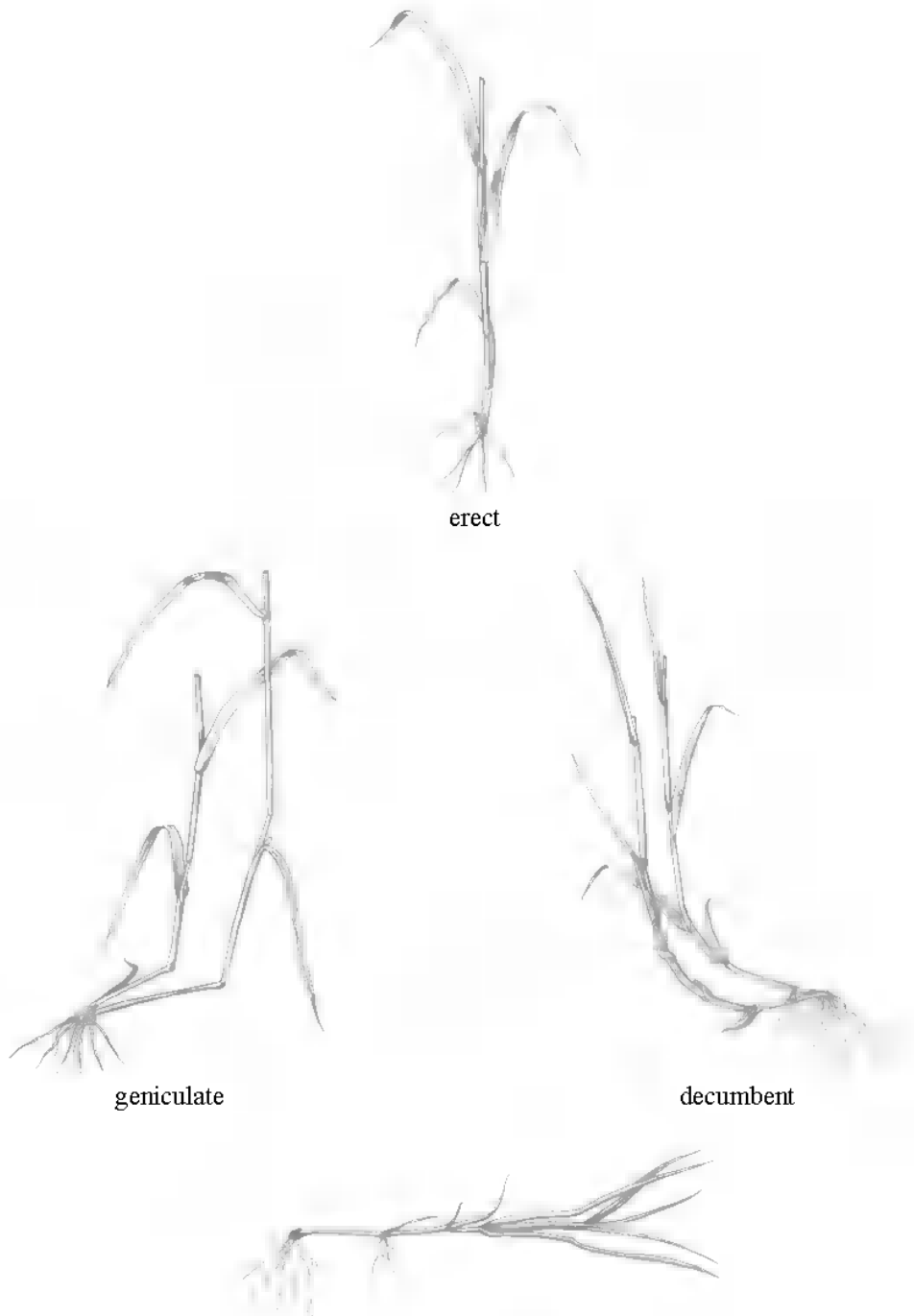
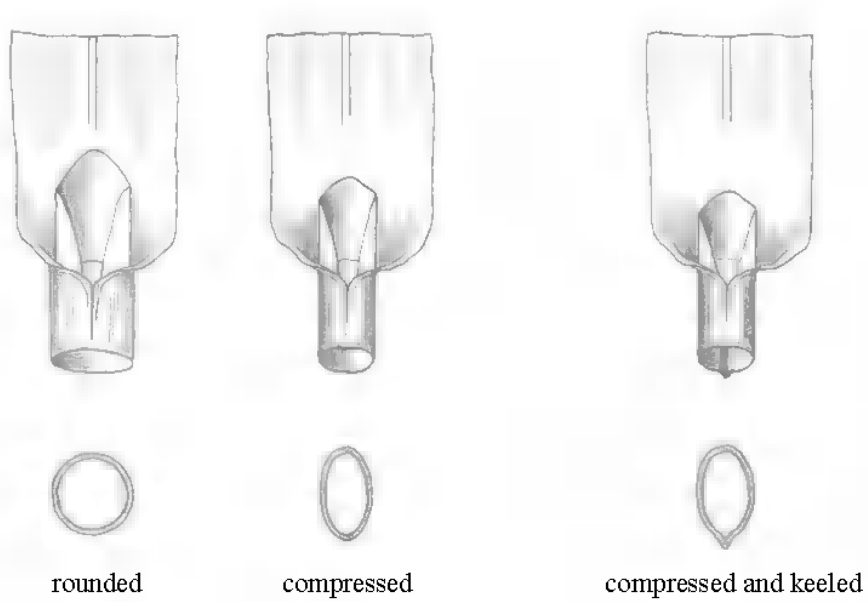
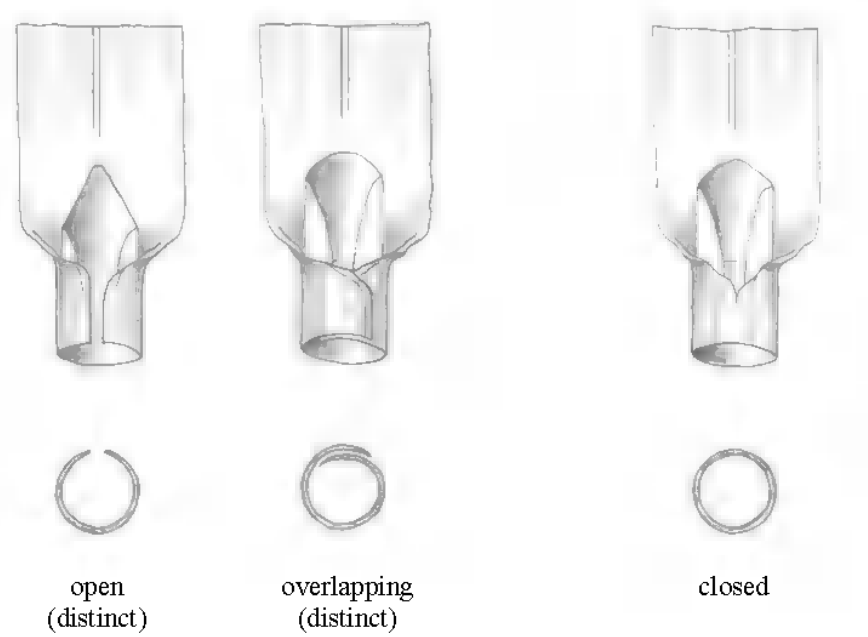


Figure 5. Culm growth habits of the grass plant. Redrawn from Hitchcock (1969).



Sheath Types



Sheath Margins

Figure 6. Sheath types (with cross-sectional outlines) and sheath margins (with cross-sectional outlines) of the grass plant. Redrawn from Hitchcock (1969).

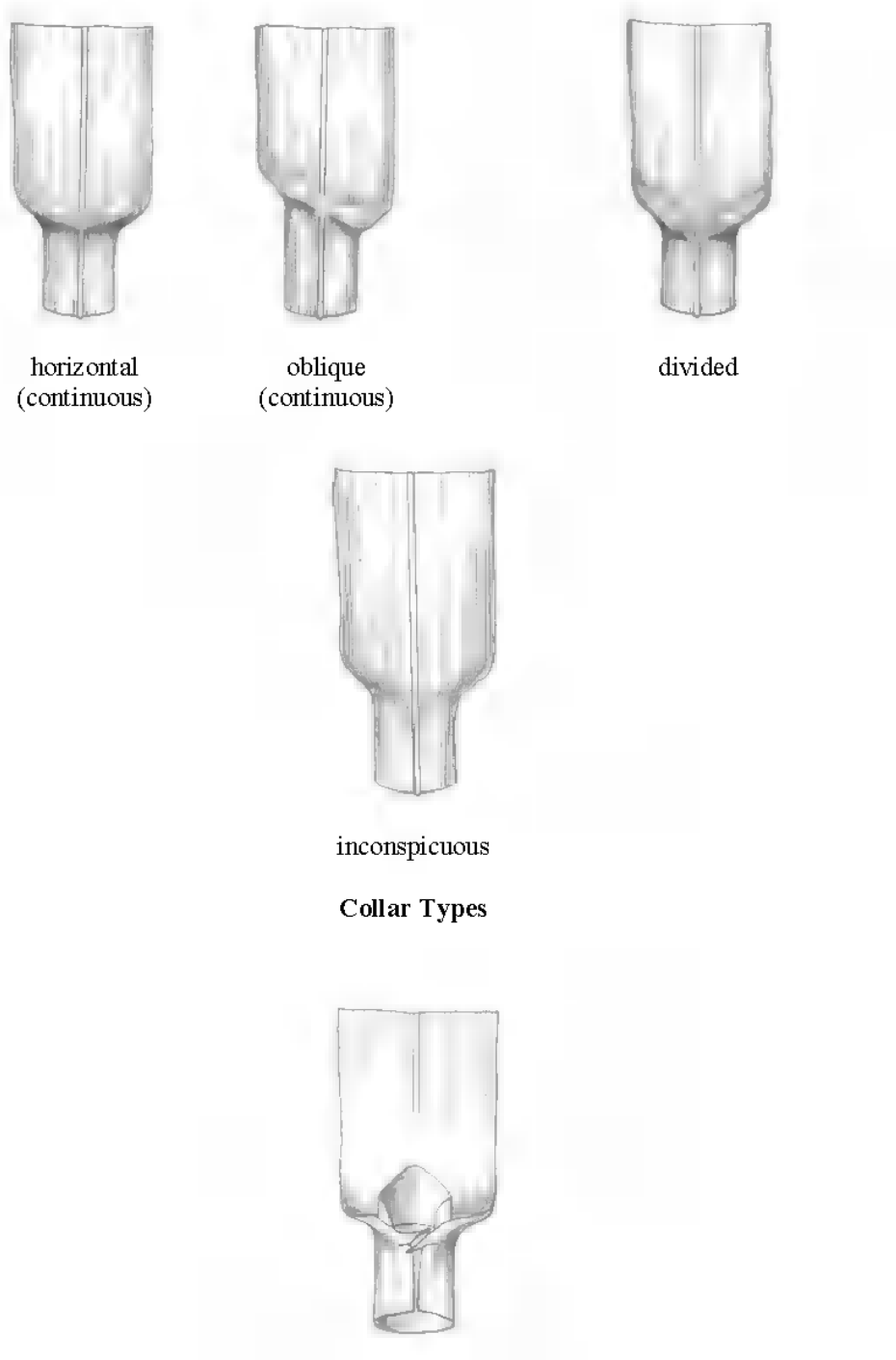
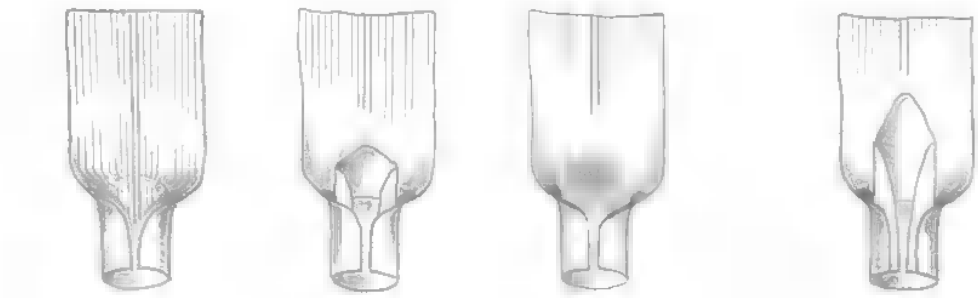
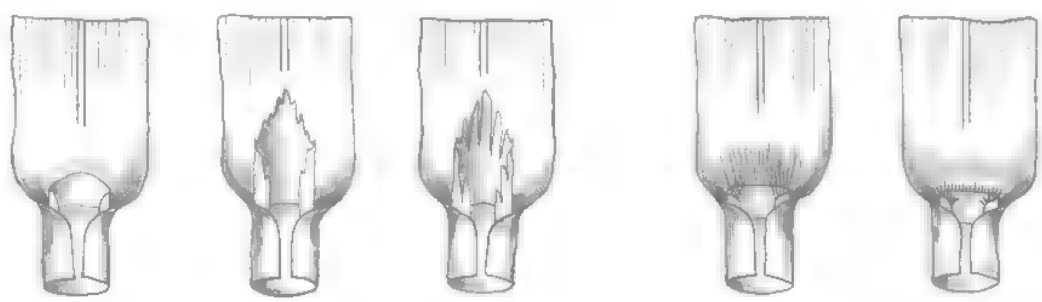


Figure 7. Collar types and auricle morphology of the grass plant. Redrawn from Hitchcock (1969).



Ligule Types

Ligule Apex Shapes (membranous)



Ligule Margins (membranous)

Figure 8. Ligule types, ligule apex shapes and ligule margins of the grass plant. Redrawn from Hitchcock (1969).

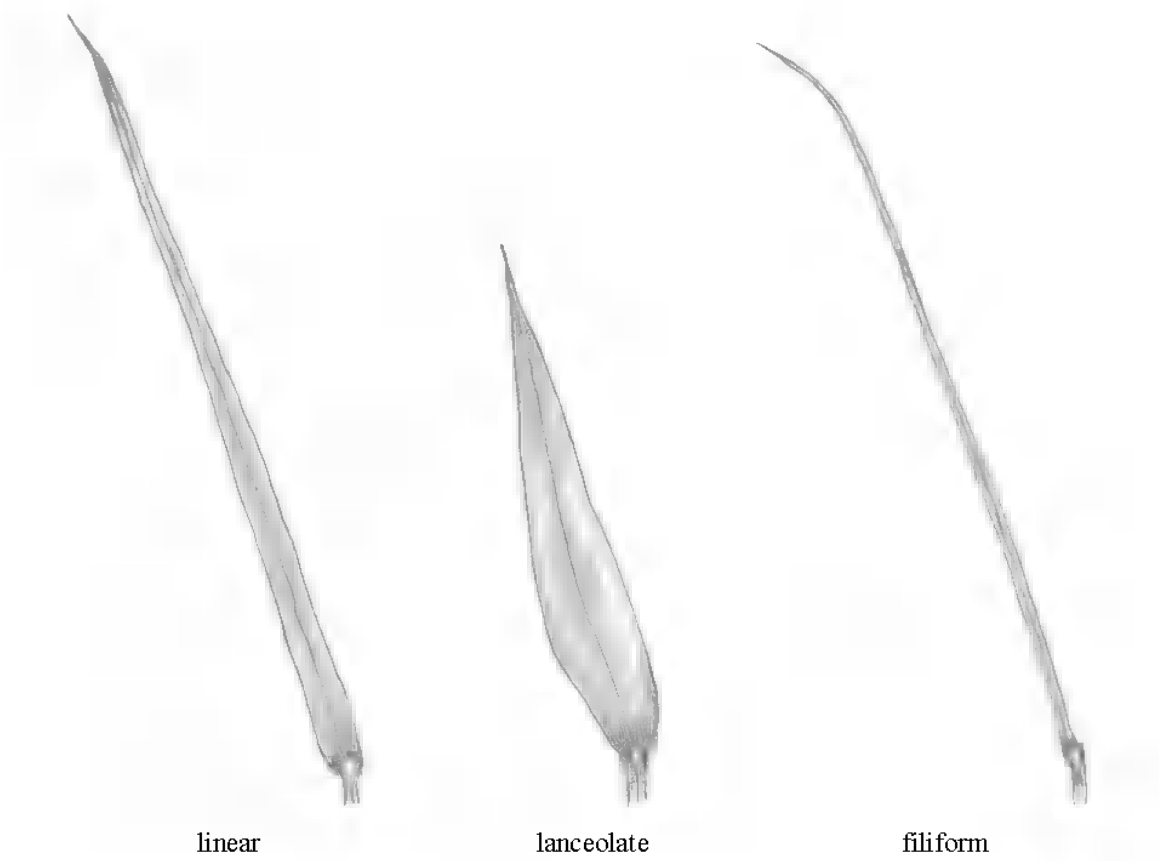
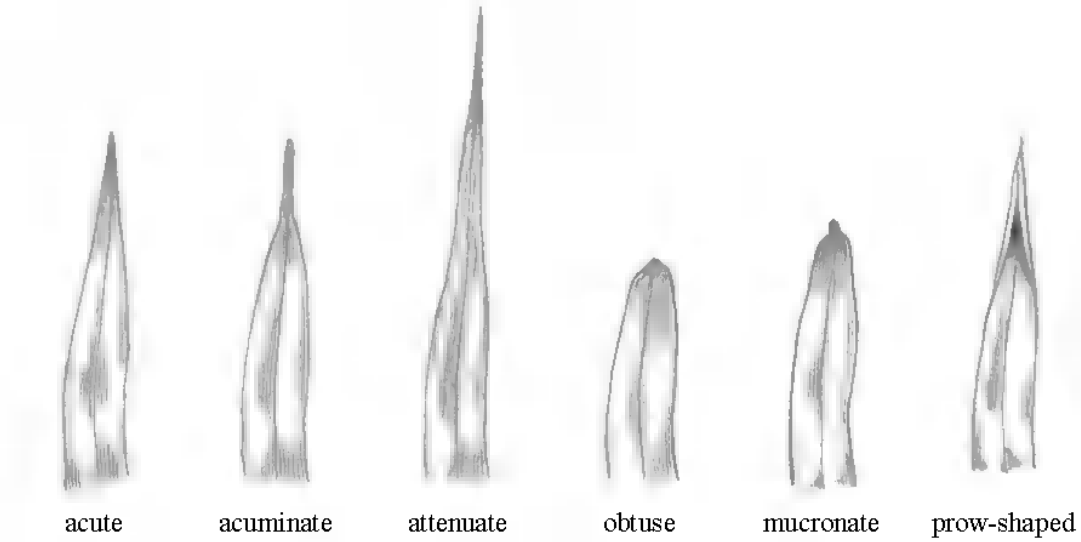
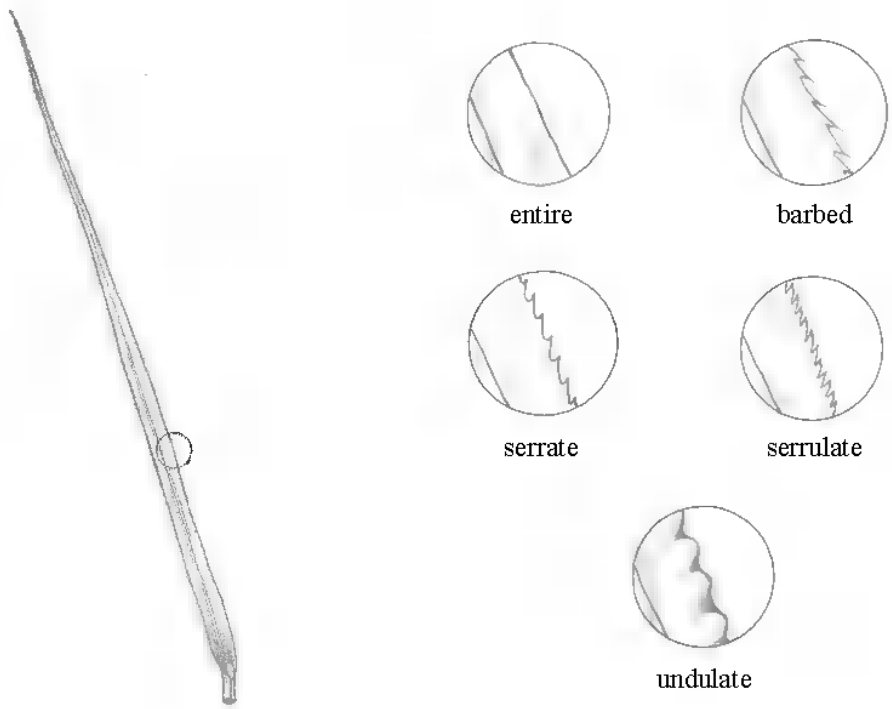


Figure 9. Blade outline shapes [redrawn from Gould (1975) and Hitchcock (1969)] and blade cross sectional outlines [redrawn from Judd et al. (1999)] of the grass plant.

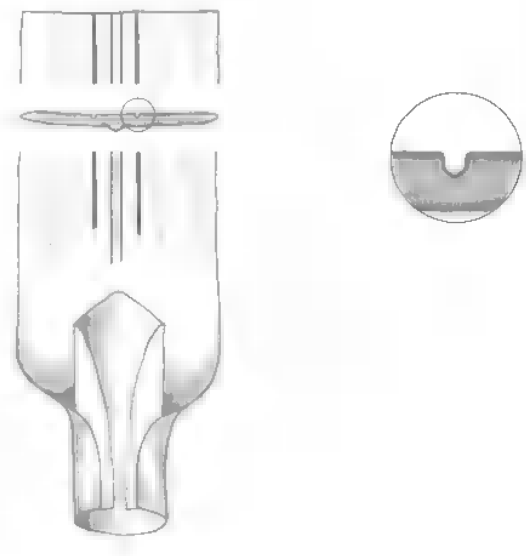


Blade Apices



Blade Margins

Figure 10. Blade apices [redrawn from Hitchcock (1969)] and blade margins [redrawn from Hitchcock (1969) and Woodland (2000)] of the grass plant.



Median Lines

Vernation Types

Figure 11. Median lines and blade vernation types (shown in cross sectional outline) of the grass plant. Redrawn from Hitchcock (1969).

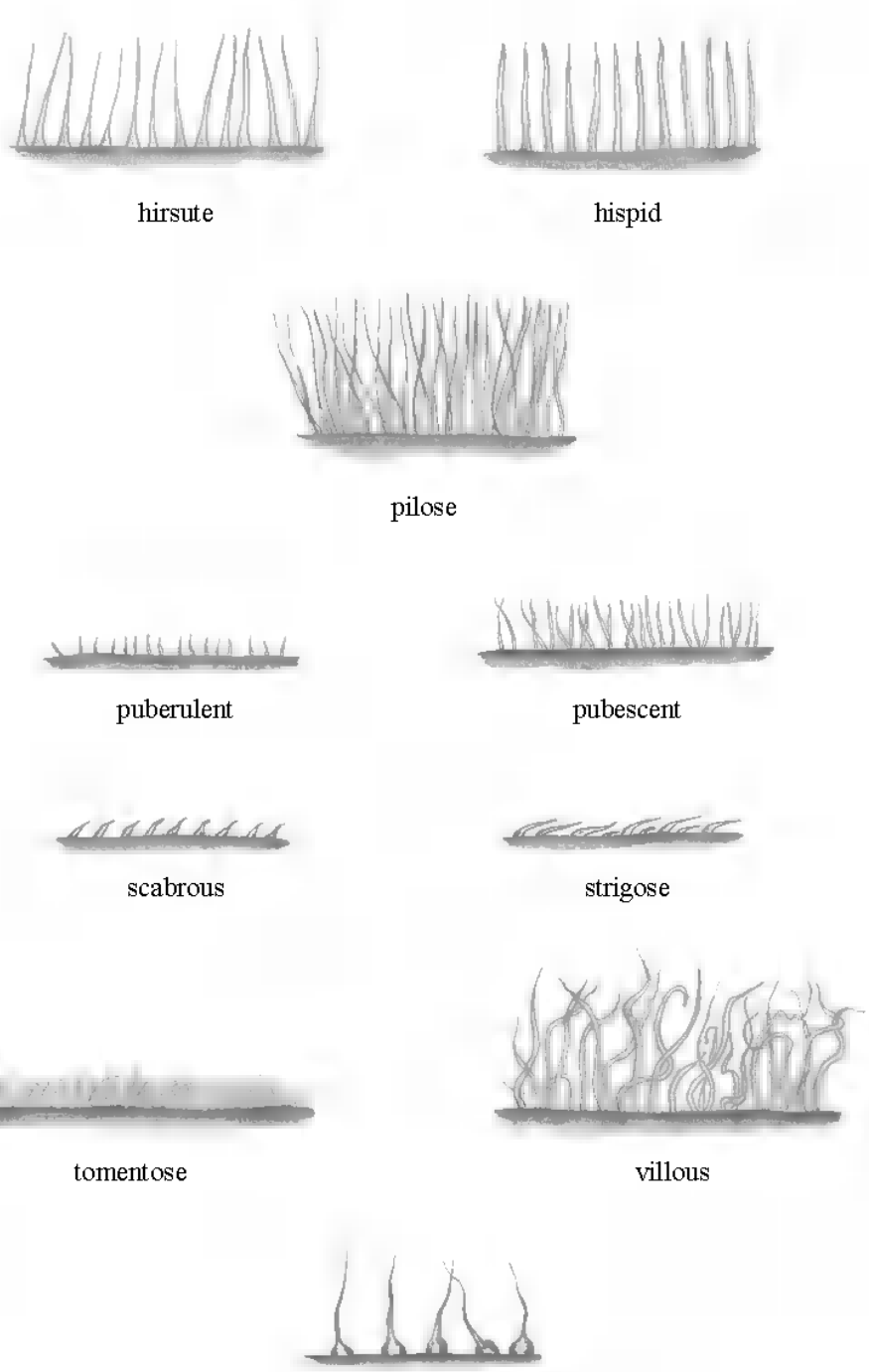


Figure 12. Vestiture types of the grass plant. Redrawn from Walters and Keil (1996).

Vegetative key to grasses of the Texas Hill Country

In addition to the key, a millimeter scale and 10x hand lens will prove valuable and are often necessary to make an accurate determination.

1. Ligules absent

2.Culm nodes (at least some) antrorsely pubescent

3. Blades linear; collars pilose, margins pilose ..... **Nassella leucotricha**
3. Blades lanceolate; collars glabrous, margins glabrous ..... **Dichanthelium sphaerocarpon**

2. Culm nodes (all) glabrous

4. Blade margins entire

5. Leaves typically marked with purple-colored bands, V-shaped markings, or irregular blotches ..... **Echinochloa colona**
5. Leaves green or purplish, but without bands, V-shaped markings, or irregular blotches ..... **Echinochloa crus-pavonis**

4. Blade margins serrulate ..... **Echinochloa crus-galli**

1. Ligules present

6. Auricles present

7. Sheath margins adnate to the auricles or ligule

8. Culm nodes glabrous

9. Ligule margin entire; midnerve inconspicuous ..... **Lolium perenne**
9. Ligule margin erose to lacerate; midnerve conspicuous ..... **Muhlenbergia arenacea**

8. Culm nodes puberulent or hispid ..... **Sorghastrum nutans**

7. Sheath margins free, not united with the auricles or ligule

10. Sheath margins ciliate along the entire length

11. Plants annual; culms erect or geniculate; blades <4 mm wide, apex acute ..... **Aegilops cylindrica**
11. Plants perennial; culms decumbent; blades ≥4 mm wide, apex attenuate ..... **Elymus canadensis**

10. Sheath margins glabrous along the entire length

12. Ligules >1 mm long

13. Lowermost sheaths glabrous externally; ligule margin entire ..... **Hordeum vulgare**

13. Lowermost sheaths pubescent externally; ligule margin erose ..... **Triticum aestivum**

12. Ligules ≤1 mm long

14. Sheaths pubescent externally; ligules <0.5 mm long, margin entire, glabrous ..... **Hordeum pusillum**
14. Sheaths glabrous, pilose or sparsely hispid externally; ligules ≥0.5 mm long, margin erose, erose and ciliolate, or lacerate

15. Ligule margin lacerate, glabrous ..... **Lolium temulentum**
15. Ligule margin erose or erose and ciliolate

16. Plants perennial; culms >60 cm tall; collar often purplish ..... **Elymus virginicus**
16. Plants annual; culms ≤60 cm tall; collar not purplish ..... **Hordeum murinum**

6. Auricles absent

17. Culm nodes with hairs, the hairs occasionally restricted to the upper or lower nodes

18. Ligule membranous, the margins entire, erose or lacerate

19. Sheath margins with hairs, the hairs occasionally restricted to the outer margin

20. Collars pilose ..... **Nassella leucotricha**
20. Collars glabrous

21. Culm nodes villous with hairs 1–3 mm long; collars divided ..... **Bothriochloa barbinodis**
21. Culm nodes pubescent; collars continuous

22. Blade apex attenuate, adaxial surface glabrous ..... **Bothriochloa laguroides**
22. Blade apex acute, adaxial surface mostly glabrous, but with a few long hairs immediately above the ligule ..... **Hilaria mutica**

19. Sheath margins glabrous

23. Collars sparsely puberulent to pubescent

24. Blade margins serrate ..... **Leersia oryzoides**
24. Blade margins entire ..... **Dichanthium annulatum**

23. Collars glabrous

25. Rhizomes or stolons present

26. Leaf surfaces retrorsely scabrous ..... **Leersia oryzoides**
26. Leaf surfaces glabrous or sparsely pilose

27. Culms erect; blade margins scabrous ..... **Hilaria belangeri**

27. Culms decumbent; blade margins entire ..... **Paspalum distichum**

25. Rhizomes or stolons absent

28. Blade margins ciliate basally

29. Upper culm nodes glabrous; blades filiform ..... **Bothriochloa edwardsiana**
29. Upper culm nodes antrorsely pubescent; blades linear ..... **Bothriochloa hybrida**

28. Blade margins glabrous

30. Collars divided ..... **Bothriochloa barbinodis**
30. Collars continuous

31. Sheath margins closed to within a few centimeters of the throat ..... **Bromus japonicus**
31. Sheath margins distinct, open along the entire length

32. Culm nodes sparsely pilose; ligule margin lacerate ..... **Tridens eragrostoides**
32. Culm nodes pubescent; ligule margin erose

33. Abaxial surface of blades pubescent ..... **Bromus texensis**
33. Abaxial surface of blades glabrous or scabrous

34. Blades lanceolate ..... **Paspalum pubiflorum**
34. Blades linear

35. Adaxial surface of blades hispid with papillose hairs ..... **Bothriochloa ischaemum**
35. Adaxial surface of blades glabrous, scabrous, pillose or sparsely hirsute, the hairs, when present, not papillose

36. Plants perennial; culm nodes pubescent; sheaths glabrous externally ..... **Bromus pubescens**
36. Plants annual; culm nodes retrorsely pubescent; sheaths glabrous or sparsely pilose externally ..... **Bromus secalinus**

18. Ligule a fringe of hairs or membranous with a ciliate or ciliolate margin

37. Sheath margins with hairs, the hairs occasionally restricted to the outer margin

38. Blades lanceolate

39. Collars glabrous

40. Blade margins entire, crispate, cartilaginous, white-colored ..... **Dichanthelium sphaerocarpon**
40. Blade margins entire, plane, not cartilaginous, not white-colored

41. Sheaths pilose externally with papillose hairs, margins ciliate along their entire length ..... **Dichanthelium oligosanthes**
41. Sheaths glabrous or pilose externally, the hairs, when present, not papillose, margins ciliate only near the throat ..... **Dichanthelium pedicellatum**

39. Collars pubescent

42. Adaxial surface of lowermost blades glabrous ..... **Dichanthelium oligosanthes**
42. Adaxial surface of lowermost blades hispid or hirsute

43. Collars perpendicular, margins pubescent ..... **Panicum capillare**
43. Collars oblique, margins glabrous ..... **Urochloa fusca**

38. Blades linear

44. Ligules ciliate with a mixture of short and long hairs

45. Culm internodes distally pubescent; sheath margins ciliate along the entire length ..... **Dichanthelium acuminatum**
45. Culm internodes glabrous; sheath margins ciliate only near the throat ..... **Panicum virgatum**

44. Ligules ciliate with hairs of a uniform length

46. Collars glabrous

47. Ligules ≤1 mm long; blade margins with papillose hairs ..... **Triplasis purpurea**
47. Ligules >1 mm long; blade margins glabrous

48. Plants perennial; collar margins pilose ..... **Setaria villosissima**
48. Plants annual; collar margins glabrous ..... **Setaria viridis**

46. Collars pubescent or pilose

49. Sheaths hispid externally with papillose hairs ..... **Panicum capillare**
49. Sheaths glabrous or pilose externally, the hairs, when present, not papillose

50. Plants annual; culm nodes hirsute; blades hispid ..... **Setaria grisebachii**
50. Plants perennial; culm nodes antrorsely puberulent; blades scabrous and finely pubescent ..... **Setaria scheelei**

37. Sheath margins glabrous

51. Collars pubescent

52. Blades linear

53. Ligules >1 mm long; blade margins hyaline or white-colored; midnerve conspicuous, usually white or greenish white ..... **Sorghum halepense**
53. Ligules ≤1 mm long; blade margins opaque, green-colored; midnerve inconspicuous, green-colored ..... **Tridens muticus**

52. Blades lanceolate

54. Sheath margins overlapping; collars oblique; blade margins entire ..... **Urochloa fusca**
54. Sheath margins open; collars perpendicular; blade margins serrate ..... **Urochloa texana**

51. Collars glabrous

55. Abaxial surface of blades with hairs

56. Sheath margins closed to within a few centimeters of the throat ..... **Bromus japonicus**
56. Sheath margins distinct, open along the entire length

57. Plants mat-forming; culms decumbent or prostrate, <20 cm tall ..... **Eragrostis reptans**
57. Plants cespitose; culms erect or geniculate, ≥20 cm tall

58. Sheaths glabrous or hispid externally with papillose hairs ..... **Panicum coloratum**
58. Sheaths puberulent or pubescent externally, the hairs, when present, not papillose

59. Plants annual; culm internodes glabrous or puberulent, nodes puberulent ..... **Eriochloa contracta**
59. Plants perennial; culm internodes pubescent, nodes antrorsely pubescent ..... **Eriochloa sericea**

55. Abaxial surface of blades glabrous or scabrous

60. Culm internodes pubescent

61. Plants annual, mat-forming; culms decumbent or prostrate, <20 cm tall; ligules <0.5 mm long ..... **Eragrostis reptans**
61. Plants perennial, cespitose; culms erect, ≥20 cm tall; ligules ≥0.5 mm long ..... **Eriochloa sericea**

60. Culm internodes glabrous

62. Sheaths scabrous externally; blades scabrous ..... **Tridens buckleyanus**
62. Sheaths glabrous or with hairs externally; blades glabrous or with hairs, but not scabrous

63. Blade margins scabrous or barbed

64. Ligules ciliate with both short and long hairs; blade margins scabrous ..... **Panicum virgatum**
64. Ligules ciliate with hairs of a consistent length; blade margins barbed ..... **Tridens albescens**

63. Blade margins entire

65. Rhizomes elongate; sheaths occasionally purplish; blade margins hyaline or whitish ..... **Sorghum halepense**
65. Rhizomes short or absent; sheaths green-colored; blade margins not hyaline or whitish

66. Collar margins puberulent or pilose

67. Culm nodes antrorsely pubescent; sheaths laterally compressed and keeled ..... **Panicum antidotale**
67. Culm nodes puberulent; sheaths rounded, not keeled ..... **Pennisetum ciliare**

66. Collar margins glabrous or sparsely villous

68. Collar margins glabrous ..... **Panicum coloratum**
68. Collar margins sparsely villous

69. Lower sheaths pilose externally, upper sheaths pubescent externally, the hairs not papillose; ligules sparsely ciliate; blades green ..... **Bromus pubescens**
69. Lower sheaths and upper sheaths glabrous or pilose externally with papillose hairs; ligule ciliate; blades glaucous ..... **Panicum hallii**

17. Culm nodes glabrous

70. Ligules membranous, the margins entire, erose or lacerate

71. Sheaths with hairs externally, the hairs occasionally restricted to the upper or lower sheaths

72. Collar margins pilose

73. Sheaths pilose externally with papillose hairs; blade margins undulate and white-colored ..... **Digitaria ciliaris, D. sanguinalis**
73. Sheaths pubescent, sparsely pilose or sparsely villous externally, the hairs not papillose; blade margins plane, not white colored

74. Collars pubescent ..... **Paspalum setaceum**
74. Collars glabrous

75. Plants perennial; culms ≥80 cm tall; blade apex acute, adaxial surface pilose behind and immediately above the ligule with hairs to 5 mm long ..... **Andropogon gerardii**

75. Plants annual; culms <80 cm tall; blade apex obtuse, adaxial surface glabrous, occasionally villous basally ..... **Eleusine indica**

72. Collar margins glabrous

76. Sheath margins closed to within 2–3 cm of the throat

77. Young shoots laterally compressed; collars glabrous; blades glabrous or hirsute ..... **Bromus catharticus**
77. Young shoots rounded; collars pubescent; blades pubescent ..... **Bromus tectorum**

76. Sheath margins distinct, open along the entire length

78. Ligules obtuse or acute

79. Sheaths laterally compressed

80. Culms ≤20 cm tall; ligule margin entire; blade margins entire ..... **Paspalum dilatatum**
80. Culms >20 cm tall; ligule margin erose; blade margins scabrous ..... **Schizachyrium scoparium**

79. Sheaths rounded

81. Ligules decurrent, adnate with the sheath margins, margins erose ..... **Avena fatua, A. sativa**
81. Ligules free, not united with the sheath margins, margins entire or lacerate

82. Stolons present, elongate, wiry; blades glaucous .. **Hopia obtusa**
82. Stolons absent; blades green-colored

83. Plants annual; collars oblique; blades hispid ..... **Lolium perenne**
83. Plants perennial; collars perpendicular; blades glabrous or scabrous

84. Pubescence restricted to the lower sheaths, the upper sheaths glabrous; blade apex acute, adaxial surface glabrous with a fringe of long, soft hairs immediately above the ligule ..... **Paspalum urvillei**
84. Pubescence present on both the upper and lower sheaths; blade apex attenuate, adaxial surface scabrous or sparsely pilose ..... **Tridens eragrostoides**

78. Ligules truncate

85. Collars pubescent ..... **Paspalum setaceum**
85. Collars glabrous

86. Blades ≤1 mm wide, involute ..... **Vulpia octoflora**
86. Blades >1 mm wide, flat or U-shaped

87. Ligules ≤0.5 mm long

88. Culm branched basally; sheaths pilose; blade margins undulate, adaxial surface sparsely pubescent, sparsely pilose basally ..... **Digitaria cognata**
88. Culms unbranched; sheaths pubescent; blade margins plane; adaxial surface pubescent or glabrous..... **Hordeum pusillum**

87. Ligules >0.5 mm long

89. Culms erect, arising from a hard, knotty base ..... **Digitaria californica, D. insularis, D. patens**
89. Culms decumbent, arising from typical rootstock

90. Plants annual; ligule margin erose; blade apex attenuate, adaxial surface pilose, the basal hairs papillose ..... **Leptochloa mucronata**
90. Plants perennial; ligule margin entire; blade apex acute, adaxial surface mostly glabrous, but sparsely hisute basally, the hairs not papillose ..... **Paspalum pubiflorum**

71. Sheaths glabrous or scabrous externally

91. Ligules truncate

92. Collar margins pilose or sparsely villous

93. Sheath margins villous ..... **Bothriochloa laguroides**
93. Sheath margins glabrous

94. Plants perennial; culms >70 cm tall; sheaths often purplish at the base; blade apex acuminate; midnerve conspicuous ..... **Andropogon gerardii**
94. Plants annual; culms ≤70 cm tall; sheaths green-colored; blade apex obtuse; midnerve inconspicuous ..... **Eleusine indica**

92. Collar margins glabrous

95. Ligules decurrent, adnate with the sheath margins

96. Sheath margins closed along the entire length ..... **Melica nitens**
96. Sheath margins distinct, open along the entire length

97. Culms striate; ligules ≤1 mm long; blades glabrous, margins cartilaginous, whitish; midnerve conspicuous, whitish ..... **Muhlenbergia arenacea**
97. Culms without striations; ligules >1 mm long; blades scabrous, margins not cartilaginous, green; midnerve inconspicuous, green ..... **Muhlenbergia porteri**

95. Ligules free, not united with the sheath margins

98. Blades ≤1 mm wide, involute or plane

99. Plants perennial; rhizomes present; culms erect ..... **Muhlenbergia utilis**
99. Plants annual; rhizomes absent; culms geniculate or decumbent ..... **Vulpia octoflora**

98. Blades >1 mm wide, plane or slightly conduplicate

100. Sheath margins closed to within a few centimeters of throat; blade apex obtuse, often prow-shaped; median lines present ..... **Glyceria striata**
100. Sheath margins distinct, open along the entire length; blade apex acute, not prow-shaped; median lines absent

101. Plants annual; collars divided, often oblique ... **Sphenopholis obtusata**
101. Plants perennial; collars continuous, linear

102. Sheath margins villous; blade apex attenuate ..... **Bothriochloa laguroides**
102. Sheath margins glabrous; blade apex acute or mucronate

103. Culms >40 cm tall ..... **Festuca versuta**
103. Culms ≤40 cm tall

104. Sheaths slightly laterally compressed, weakly keeled; blade apex mucronate, adaxial surface glabrous or scabrous, sparsely pilose at the base ..... **Chloris andropogonoides**
104. Sheaths rounded, not keeled; blade apex acute, adaxial surface pubescent occasionally glabrous ..... **Hordeum pusillum**

91. Ligules obtuse or acute

105. Ligules obtuse

106. Collars divided ..... **Sphenopholis obtusata**
106. Collars continuous

107. Ligules decurrent, adnate with the sheath margins

108. Blade apex obtuse, often prow-shaped; median lines present ..... **Poa annua**
108. Blade apex acute, not prow-shaped; median lines absent

109. Culms ≥30 cm tall, thick; ligule margins erose; blades >3 mm wide ..... **Avena fatua, A. sativa**
109. Culms <30 cm tall, slender; ligule margins lacerate; blades ≤3 mm wide ..... **Desmazeria rigida**

107. Ligules free, not united with the sheath margins

110. Blades filiform, margins ciliate basally ..... **Bothriochloa edwardsiana**
110. Blades linear, margins glabrous or scabrous

111. Stolons present

112. Stolon nodes villous, swollen; culms erect; blades glaucous, apex attenuate ..... **Hopia obtusa**
112. Stolon nodes glabrous, not swollen; culms geniculate or decumbent; blades green-colored, apex acute ..... **Polypogon viridis**

111. Stolons absent

113. Sheath margins villous ..... **Bothriochloa laguroides**
113. Sheath margins glabrous or pilose near the throat

114. Collars oblique ..... **Lolium perenne**
114. Collars perpendicular

115. Culms branched; sheaths laterally compressed and keeled; blade margins scabrous ..... **Schizachyrium scoparium**
115. Culm unbranched; sheaths rounded, not keeled; blade margins entire

116. Blades scabrous or sparsely pilose, apex attenuate ..... **Tridens eragrostoides**
116. Blades glabrous, apex acute

117. Plants perennial; blades ≤ 3 mm wide ..... **Agrostis hyemalis**
117. Plants annual; blades > 3 mm wide ..... **Phalaris caroliniana**

105. Ligules acute

118. Lower sheaths laterally compressed

119. Blades spirally twisted upon drying, margins scabrous, whitish ..... **Schedonnardus paniculatus**
119. Blades plane or involute upon drying, margins entire, not whitish

120. Ligules free, not united with the sheath margins; blades green ..... **Muhlenbergia ×involuta**
120. Ligules decurrent, adnate with the sheath margins; blades pale green to glaucous . ..... **Muhlenbergia lindheimeri**

118. Lower sheaths rounded

121. Rhizomes present, elongate

122. Culms ≤50 cm tall; ligules ≤4mm long, nerves absent; blades ≤15 cm long, margins entire ..... **Poa arachnifera**
122. Culms >50 cm tall; ligules >4 mm long with numerous fine nerves; blades >15 cm long, margins serrate ..... **Zizaniopsis miliacea**

121. Rhizomes absent

123. Culms branched ..... **Leptochloa fusca**
123. Culms unbranched

124. Ligules decurrent, adnate with sheath margins

125. Ligules membranous, white-colored, margin erose ..... **Avena fatua, A. sativa**
125. Ligules membranous, not white-colored, margin lacerate ..... **Polypogon monspeliensis**

124. Ligules free, not united with the sheath margins

126. Blades filiform, arcuate, involute ..... **Muhlenbergia reverchonii**
126. Blades linear, straight, plane ..... **Tridens eragrostoides**

70. Ligules a fringe of hairs or membranous with a ciliate or ciliolate margin

127. Collar margins glabrous

128. Lowermost sheaths keeled or keeled just below the collar

129. Sheath margins with hairs, the hairs occasionally restricted to the outer margin

130. Plants perennial; sheaths distinctly broader than the blades

131. Inner and outer sheath margins pilose; blade acute ..... **Andropogon glomeratus**
131. Inner sheath margins glabrous, outer margins ciliate; apex acute ..... **Andropogon virginicus**

130. Plants annual; sheaths as broad as blades or more narrow than blades

132. Ligules <1 mm long; blades loosely twisted ..... **Setaria pumila**
132. Ligules ≥1 mm long; blades not loosely twisted

133. Outer sheath margins distally ciliate; blade margins entire and plane ..... **Setaria verticillata**
133. Outer sheath margins ciliate or pilose along the entire length; blade margins entire and undulate ..... **Setaria viridis**

129. Sheath margins glabrous

134. Rhizomes present

135. Leaf blade midnerve conspicuous, scabrous abaxially .... **Coelorachis cylindrica**
135. Leaf blade midnerve inconspicuous, glabrous abaxially ..... **Setaria parviflora**

134. Rhizomes absent

136. Blade apex acute or acuminate

137. Plants annual; blade margins pilose with papillose hairs ..... **Dactyloctenium aegyptium**
137. Plants perennial; blade margins glabrous

138. Ligules ≥1 mm long, ciliate with both short and long hairs; blades green, flat upon drying ..... **Andropogon virginicus**
138. Ligules <1 mm long; ciliate with hairs of uniform length; blades glaucous, involute upon drying..... **Leptochloa dubia**

136. Blade apex obtuse or mucronate

139. Blade margins sparsely villous basally ..... **Chloris virgata**
139. Blade margins glabrous along the entire length

140. Collars divided ..... **Chloris verticillata**
140. Collars continuous

141. Blades conduplicate, apex obtuse ..... **Chloris cucullata**
141. Blades plane; apex mucronate .... **Chloris andropogonoides**

128. Lowermost sheaths not keeled

142. Sheath margins with hairs, the hairs occasionally restricted to the outer margin

143. Rhizomes present; ligules ciliate with both short and long hairs ... **Panicum virgatum**
143. Rhizomes absent; ligules ciliate with hairs of a uniform length

144. Sheath margins with hairs only near the throat

145. Ligules ≤0.5 mm long; blades green, adaxial surface mostly glabrous, but pilose basally ..... **Steinchisma hians**
145. Ligules >0.5 mm long; blades pale green to glaucous, adaxial surface glabrous or scabrous along entire length ..... **Setaria leucopila**

144. Sheath margins pilose or sparsely hirsute along the entire length

146. Plants annual; sheath margins sparsely hirsute; blades filiform, scabrous ..... **Aristida oligantha**
146. Plants perennial; sheath margins pilose; blades linear, glabrous ..... **Eragrostis superba**

142. Sheath margins glabrous

147. Blade margins with few to many hairs

148. Rhizomes present

149. Ligules <1 mm long; upper and lower collars glabrous; blades <2 mm wide ..... **Bouteloua trifida**
149. Ligules ≥1 mm long; upper collars glabrous, lower collars pubescent; blades ≥2 mm wide ..... **Setaria reverchonii**

148. Rhizomes absent

150. Hairs of the blade margins simple; vernation folded ..... **Bouteloua uniflora**
150. Hairs of the blade margins papillose; vernation rolled

151. Plants glaucous; ligules ≥0.5 mm long ..... **Panicum hallii**
151. Plants green; ligules <0.5 mm long

152. Blade surface glabrous; blade margins glabrous along upper half becoming sparsely pilose with papillose hairs along lower half, plane, not cartilaginous, green ..... **Bouteloua repens**
152. Blade surface scabrous; blade margins pilose with papillose hairs along entire length, cartilaginous, whitish ..... **Urochloa ciliatissima**

147. Blade margins glabrous

153. Rhizomes present

154. Ligules ciliate with both short and long hairs ..... **Panicum virgatum**
154. Ligules ciliate with hairs of a uniform length

155. Culm nodes often reddish-purple; blades lanceolate, adaxial surface sparsely pilose at base .....**Chasmanthium latifolium**
155. Culm nodes not reddish-purple; blades linear, adaxial surface glabrous

156. Leaves distichous; blade margins scabrous ..... **Arundo donax**
156. Leaves not conspicuously distichous; blade margins entire or scabrous

157. Culms erect, reed-like; blade margins entire, apex attenuate, often involute ..... **Phragmites australis**
157. Culms erect or geniculate, not reed-like; blade margins scabrous, apex attenuate, not involute .... **Tripsacum dactyloides**

153. Rhizomes absent

158. Ligules <0.5 mm long ..... **Aristida longespica**
158. Ligules ≥0.5 mm long

159. Culms arising from a hard, knotty base

160. Sheaths glabrous externally; blade adaxial surface scabrous,

occasionally sparsely pilose, vernation folded
..... **Cenchrus myosuroides**
160. Sheaths glabrous or hispid externally with papillose hairs; blade adaxial surface glabrous or hirsute, vernation rolled
..... **Panicum coloratum**

159. Culm base not hard and knotty

161. Blades hispid or pilose abaxially

162. Culms decumbent; sheaths pilose externally with papillose hairs ..... **Leptochloa mucronata**
162. Culms erect or geniculate; sheaths glabrous, hirsute or hispid externally, the hairs, when present, not papillose
..... **Trisetum interruptum**

161. Blades glabrous abaxially

163. Culms branched basally ..... **Aristida adscensionis**
163. Culms unbranched

164. Plants annual; blades >30 cm long, >10 mm wide
..... **Sorghum bicolor**
164. Plants perennial; blades ≤30 cm long, ≤10 mm wide

165. Culms glaucous; sheath margins open; blades glaucous, adaxial surface glabrous to sparsely pilose
..... **Panicum hallii**
165. Culms green; sheath margins overlapping; blades green, adaxial surface scabrous with a fringe of long, soft hairs above the ligule
..... **Pappophorum vaginatum**

127. Collar margins pilose or pubescent

166. Collars hirsute, pilose or pubescent

167. Rhizomes present, short and knotty

168. Lowermost sheaths rounded, not keeled, upper sheath margins overlapping
..... **Eragrostis spectabilis**

168. Lowermost sheaths compressed and keeled, upper sheath margins open
..... **Tridens flavus**

167. Rhizomes absent

169. Plants annual; culms geniculate or decumbent, usually with a pale yellow band of glandular tissue just below the node ..... **Eragrostis barrelieri**
169. Plants perennial; culms erect or geniculate, glandular tissue absent

170. Sheath margins distinct, open, outer margin ciliate ..... **Eragrostis intermedia**
170. Sheath margins distinct, overlapping, outer margin glabrous

171. Culm internodes glabrous; sheaths glabrous externally; blades glabrous abaxially ..... **Pappophorum bicolor**
171. Culm internodes pilose; sheaths glabrous or pilose externally; blades hispid abaxially ..... **Tridens texanus**

166. Collars glabrous

172. Sheaths keeled, at least below the collar

173. Rhizomes or stolons present ..... **Stenotaphrum secundatum**
173. Rhizomes or stolons absent

174. Sheath margins pilose

175. Plants perennial; culms erect, stout; blades glabrous ..... **Andropogon glomeratus**
175. Plants annual; culms geniculate or decumbent, slender; blades scabrous ..... **Cenchrus longispinus**

174. Sheath margins glabrous

176. Sheaths shorter than the adjacent internode

177. Plants perennial; culms ≥75 cm tall; lowermost sheaths hispid externally; blades <2 mm wide ..... **Eragrostis curvula**
177. Plants annual; culms <75 cm tall; lowermost sheaths glabrous externally; blades ≥2 mm wide

178. Glandular tissue present in a ring just below culm nodes; midnerve conspicuous, whitish ..... **Eragrostis cilianensis**
178. Glandular tissue absent; midnerve inconspicuous, green ..... **Eragrostis pectinacea**

176. Sheaths at least as long as the adjacent internode

179. Blades ≤2 mm wide, apex indurate, whitish; midnerve conspicuous, whitish ..... **Erioneuron pilosum**
179. Blades >2 mm wide, apex not indurate; midnerve inconspicuous, not whitish

180. Ligules membranous, brown-colored, margin ciliate; collar margins sparsely villous ..... **Heteropogon contortus**
180. Ligules ciliate; collar margins pilose ..... **Pennisetum ciliare**

172. Sheaths not keeled

181. Ligules ≥0.5 mm long

182. Sheaths laterally compressed

183. Plants perennial; culms >80 cm tall; sheaths purplish at base; blades green to glaucous, adaxial surface pilose at base and behind ligule with hairs to 5 mm long ..... **Andropogon gerardii**
183. Plants annual; culms ≤80 cm tall; sheaths green at base; blades green, adaxial surface glabrous with a few long soft hairs behind ligule ..... **Cenchrus spinifex**

182. Sheaths rounded

184. Rhizomes or stolons present

185. Plants stoloniferous; culms ≤10 cm tall; blade apex attenuate, margins entire, occasionally with a few pustulate hairs; vernation folded ..... **Buchloë dactyloides**
185. Plants rhizomatous; culms >10 cm tall; blade apex acute, margins scabrous ..... **Panicum virgatum**

184. Rhizomes or stolons absent

186. Blade margins hispid or with a few papillose hairs basally

187. Abaxial surface of blade with a few papillose hairs, these often occurring along the midnerve ..... **Bouteloua hirsuta**
187. Abaxial surface of blade glabrous

188. Sheaths shorter than adjacent internodes; blade margins hispid, cartilaginous, whitish ..... **Tragus berteronianus**
188. Sheaths at least as long as adjacent internodes; blade margins mostly glabrous or with a few papillose hairs basally, not cartilaginous, not whitish

189. Plants annual; blades <2 mm wide, adaxial surface scabrous to sparsely strigose ..... **Bouteloua barbata**
189. Plants perennial; blades ≥2 mm wide, adaxial surface glabrous ..... **Panicum hallii**

186. Blade margins entire or strigose

190. Abaxial blade surface pilose ..... **Setaria villosissima**
190. Abaxial blade surface glabrous or scabrous

191. Sheath margins distinct, open

192. Sheaths shorter than djacent internodes, the outer margin ciliate; blade margin strigose ..... **Sporobolus pyramidatus**
192. Sheaths at least as long as adjacent internode, the outer margin glabrous; blade margins glabrous

193. Leaves mostly basal; collar margins villous; blades ≤2 mm wide, green, involute; vernation folded ..... **Aristida purpurea**
193. Leaves cauline; collar margins sparsely villous; blades >2 mm wide, glaucous, plane; vernation rolled ..... **Panicum hallii**

191. Sheath margins distinct, overlapping

194. Adaxial blade surface scabrous with a fringe of long, soft hairs just above the ligule ..... **Pappophorum vaginatum**
194. Adaxial blade surface glabrous or scabrous

195. Sheath outer margin ciliate; collar margins hirsute; blades involute ..... **Eragrostis lugens**
195. Sheath outer margin glabrous; collar margins pilose; blades plane or conduplicate ..... **Sporobolus cryptandrus**

181. Ligules <0.5 mm long

196. Rhizomes or stolons present

197. Plants rhizomatous

198. Leaves distichous; collar hairs simple; blade margins glabrous along entire length ..... **Cynodon dactylon**
198. Leaves not distichous; collar hairs pustulate; blade margins glabrous, but with a few papillose hairs at base..... **Bouteloua curtipendula**

197. Plants stoloniferous

199. Leaves ± distichous; sheaths compressed; blades conduplicate, apex obtuse..... ..... **Stenotaphrum secundatum**
199. Leaves not distichous; sheaths rounded; blades flat, apex acute ..... **Muhlenbergia schreberi**

196. Rhizomes or stolons absent

200. Culms branched basally

201. Lowermost sheath margins entire ..... **Aristida longispica**
201. Lowermost sheath margins sparsely hirsute ..... **Aristida oligantha**

200. Culms unbranched

202. Sheath margins distinct, overlapping

203. Culms viscid ..... **Eragrostis curtipedicellata**
203. Culms not viscid

204. Lowermost sheaths glabrous along the entire length ..... **Eragrostis secundiflora, E. trichodes**
204. Lowermost sheaths pilose near throat ..... **Sporobolus clandestinus, S. compositus**

202. Sheath margins distinct, open

205. Sheaths shorter than the adjacent internode

206. Culms erect; sheaths glabrous or sparsely pilose externally; collar margins with 1 or 2 long, soft hairs on each side ..... **Sporobolus vaginiflorus**
206. Culms geniculate or decumbent; sheaths glabrous externally; collar margins sparsely villous or sparsely ciliate, the hairs numbering more than 1 or 2 on each side

207. Plants annual; blades plane, conduplicate or involute, adaxial surface often sparsely hirsute basally ..... **Bouteloua aristidoides**
207. Plants perennial; blades plane, adaxial surface sparsely pubescent basally ..... **Muhlenbergia schreberi**

205. Sheaths at least as long as the adjacent internode

208. Blades ≥2 mm wide ..... **Sporobolus airoides**
208. Blades <2 mm wide

209. Leaves cauline; blades linear, sparsely pilose ..... **Bouteloua rigidiseta**
209. Leaves mostly basal; blades filiform, glabrous or sparsely hirsute ..... **Tripogon spicatus**

Species Descriptions

1. AEGILOPS CYLINDRICA Host — JOINTED GOATGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–80 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, ciliate. **Collar** continuous, glabrous; margins ciliate. **Auricles** <1 mm long. **Ligules** 0.5 mm long, membranous, truncate; margins entire to slightly erose. **Leaf blades** linear, 4–12 cm long, 1–3(–4) mm wide, plane but often conduplicate when dry, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces sparsely hirsute to glabrous. **Vernation** folded. Occasional along open roadsides and in disturbed areas.

2. AGROSTIS HYEMALIS (Walt.) B.S.P. — WINTER BENTGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 15–70 cm tall, erect with the lowermost internode reclined, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1.5–4 mm long, membranous, obtuse; margins erose or lacerate. **Leaf blades** linear, 3–9 cm long, 0.5–3 mm wide, plane, firm-textured; apex acute;

margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common along roadsides, in pastures, and in open woodlands, usually in moist, sandy soil.

3. ANDROPOGON GERARDII Vitman — BIG BLUESTEM

Plants perennial, cespitose. **Rhizomes** short or absent; **stolons** absent. **Culms** 80–200 cm tall, erect, stout, glabrous, not swollen at the base, lateral branching sparse. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, pubescent or glabrous externally, usually purplish at base; margins distinct, open, entire. **Collar** continuous, often inconspicuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 1–2.5 mm long, membranous, truncate; margins erose, occasionally sparsely ciliate. **Leaf blades** linear, 8–50 cm long, 2–10 mm wide, plane or V-shaped, firm-textured, green or glaucous; apex acuminate; margins entire; adaxial surface mostly glabrous but pilose at base behind and above ligules with hairs to 5 mm long; abaxial surface glabrous; midnerve conspicuous abaxially. **Vernation** rolled. Widespread but rarely abundant, usually associated with other tallgrass species in prairies and woodland openings and along rocky stream margins.

4. ANDROPOGON GLOMERATUS (Walt) B.S.P. — BUSHY BLUESTEM

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 75–150 cm tall, erect, stout, compressed, glabrous, not swollen at the base, lateral branching sparse. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, broader than the blades, glabrous externally; margins distinct, open, pilose. **Collar** continuous, glabrous; margins entire or sparsely pilose. **Auricles** absent. **Ligules** 1–2 mm long, membranous, truncate; margins ciliate with occasional long, fine hairs present. **Leaf blades** linear, 5–30 cm long, 3–6(–8) mm wide, plane to conduplicate, firm-textured; apex tapering to a sharp point; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** folded. Very common in low, moist sites such as stream and pond margins, seepage areas, and ditches.

5. ANDROPOGON VIRGINICUS L. — BROOMSEDGE BLUESTEM

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100 cm tall, erect, stout, glabrous, not swollen at the base, lateral branching sparse. **Culm nodes** glabrous. **Leaf sheaths** rounded, keeled just below the collar, the lowermost sheaths compressed and keeled, broader than the blades, glabrous externally; margins distinct, open, entire, occasionally the outer margins ciliate. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, truncate; margins ciliate with both long and short hairs. **Leaf blades** linear, 10–20 cm long, 2–5 mm wide, plane or conduplicate, firm-textured; apex acute; margins entire; adaxial surface glabrous or pilose basally; abaxial surface glabrous. **Vernation** folded. Widespread in east Texas, especially on disturbed sites; reported from only a few counties in the Hill Country.

6. ARISTIDA ADSCENSIONIS L. — SIXWEEKS THREEAWN

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–50(–80) cm tall, erect or geniculate, the outermost culms of a tuft decumbent, firm, glabrous, not swollen at the base, freely branched at the base. **Culm nodes** glabrous; leaf sheath rounded, often much shorter than the adjacent culm internodes, scabrous externally; margins distinct, open, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5 mm long, a fringe of hairs. **Leaf blades** linear, 5–20 cm long, 1–3 mm wide, plane to involute, firm-textured; apex acute; margins entire; adaxial surface scabrous to finely hispid; abaxial surface glabrous. **Vernation** rolled. Widespread on dry, rocky slopes and plains in west and south Texas and the panhandle, extending into the westernmost counties of the Hill Country.

7. ARISTIDA LONGESPICA Poir. — SLIMSPIKE THREEAWN

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–60(–80) cm tall, erect or geniculate, wiry, glabrous, not swollen at the base, freely branched at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, the lowermost sheaths often hispid externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire or with a few long, soft hairs. **Auricles** absent. **Ligules** <0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** filiform, 5–12 cm long, 0.5–1 mm wide, plane or involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces scabrous. **Vernation** rolled. Occasional along roadsides, in fields, and woodland openings, usually in sandy soil.

8. ARISTIDA OLIGANTHA Michx. — OLDFIELD THREEAWN

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 15–80 cm tall, erect or geniculate, wiry, glabrous, not swollen at the base, freely branched at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, sparsely hirsute. **Collar** continuous, glabrous; margins entire or with a few long, soft hairs. **Auricles** absent. **Ligules** <0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** filiform, 10–25 cm long, 1–2 mm wide, plane, firm-textured; apex attenuate, involute; margins entire; adaxial and abaxial surfaces scabrous. **Vernation** rolled. Common and widespread on disturbed, usually sandy soils.

9. ARISTIDA PURPUREA Nutt. — PURPLE THREEAWN

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–70(–90) cm tall, erect, slender, glabrous, not swollen at the base, sparsely branched at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or scabrous or puberulent externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins villous. **Auricles** absent. **Ligules** 0.5 mm long, a fringe of hairs. **Leaf blades** linear, 3–18 cm long, 1–2 mm wide, involute, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** folded. Widespread and abundant along roadsides and other disturbed sites.

10. ARUNDO DONAX L. — GIANT CANE

Plants perennial, forming large clumps. **Rhizomes** short, thick, knotty; **stolons** absent. **Culms** 2–6(–10) m tall, erect, reed-like, robust, tough, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaves** distichous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 30–60 cm long, 40–70 mm wide, plane, firm-textured; apex acuminate; margins scabrous; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common along ditches, culverts, drainages, and other moist sites.

11. AVENA FATUA L. — WILD OATS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–150 cm tall, erect or geniculate, firm, thick, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous, occasionally sparsely hispid externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–5 mm long, membranous, whitish, decurrent on either side as sheath margins, obtuse to acute; margins erose. **Leaf blades** linear, 10–45 cm long, 3–15 mm wide, plane, firm-textured; apex acute; margins entire, occasionally sparsely hispid; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** rolled. Common along roadsides, cultivated fields, and disturbed sites.

We have found no vegetative characters that can reliably distinguish this species from *A. sativa*.

12. AVENA SATIVA L. — CULTIVATED OATS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–150 cm tall, erect or geniculate, firm, thick, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous, occasionally sparsely hispid externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–5 mm long, membranous, whitish, decurrent on either side as sheath margins, obtuse to acute; margins erose. **Leaf blades** linear, 10–45 cm long, 3–15 mm wide, plane, firm-textured; apex acute; margins entire, occasionally sparsely hispid; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** rolled. A common spring crop species that is widespread in the Hill Country.

We have found no vegetative characters that can reliably distinguish this species from *A. fatua*.

13. BOTHRIOCHLOA BARBINODIS (Lag.) Herter — CANE BLUESTEM

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 60–120 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** villous with hairs 1–3 mm long. **Leaf sheaths** rounded, glabrous or sparsely pilose externally; margins distinct, open, entire, occasionally the outer margins ciliate. **Collar** divided, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, obtuse; margins erose or lacerate. **Leaf blades** linear, 25–30 cm long, 2–7 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous; midnerve conspicuous abaxially. **Vernation** rolled. Common along roadsides and on rocky or gravelly slopes.

14. BOTHRIOCHLOA EDWARDSIANA (Gould) Parodi — MERRILL BLUESTEM

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 35–65 cm tall, erect or geniculate, slender, glabrous, not swollen at the base. **Culm nodes** glabrous or densely pubescent below, glabrous above. **Leaf sheaths** rounded, glabrous externally;.0 margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–1.5 mm long, membranous, obtuse; margins erose. **Leaf blades** filiform, 10–25 cm long, 1–2(–3.5) mm wide, plane, firm-textured, pruinose; apex acute; margins entire distally, ciliate basally; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Uncommon in rocky soils of grasslands.

15. BOTHRIOCHLOA HYBRIDA (Gould) Gould — HYBRID BLUESTEM

Plants perennial, forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 30–80 cm tall, erect, firm, glabrous, not swollen at the base, freely branched above the base. **Culm nodes** antrorsely pubescent. **Leaf sheaths** rounded, glabrous externally, green or glaucous; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, truncate; margins fimbriate. **Leaf blades** linear, 8–25(–30) cm long, 2–4(–5) mm wide, plane, firm-textured; apex acute; margins entire, sparsely ciliate basally; adaxial surface glabrous, sparsely hirsute basally; abaxial surface glabrous. **Vernation** rolled. Often abundant along roadsides, in pastures, and on rangeland.

16. BOTHRIOCHLOA ISCHAEMUM (L.) Keng — KING RANCH BLUESTEM

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–50(–100) cm tall, erect or decumbent, firm, glabrous, not swollen at the base. **Culm nodes** antrorsely pubescent, glabrate with age. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 10–20 cm long, 2–5 mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial surface sparsely hispid with papillose hairs; abaxial surface glabrous. **Vernation** folded. Widespread and abundant along roadsides, field margins, and opther disturbed sites.

17. BOTHRIOCHLOA LAGUROIDES (DC.) Herter — SILVER BLUESTEM

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 35–120 cm tall, erect or somewhat geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous or pubescent. **Leaf sheaths** slightly laterally compressed, keeled near collar, glabrous externally; margins distinct, open, villous. **Collar** continuous, glabrous; margins entire or sparsely villous. **Auricles** absent. **Ligules** 1–3 mm long, membranous, obtuse to truncate; margins erose. **Leaf blades** linear, 8–25 cm long, 3–6(–8) mm wide, plane or weakly keeled, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common along roadsides, in grasslands, and along woodland margins.

18. BOUTELOUA ARISTIDOIDES (Kunth) Griseb. — NEEDLE GRAMA

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 6–50 cm tall, geniculate, the outermost culms of a tuft decumbent, weak, slender, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, usually much shorter than the adjacent culm internodes, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins sparsely villous. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 2–7 cm long, 1–2 mm wide, plane or conduplicate or involute, thin; apex acute; margins entire; adaxial surface glabrous often sparsely hirsute basally; abaxial surface glabrous. **Vernation** folded. Occasional on dry, rocky slopes, along washes, and on gravelly sites.

19. BOUTELOUA BARBATA Lag. — SIXWEEKS GRAMA

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 6–50 cm tall, erect or geniculate, the outermost culms of a tuft decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins sparsely villous. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 2–7 cm long, 1(–3) mm wide, plane or involute, thin; apex acute; margins entire with some papillose hairs basally; adaxial surface scabrous or sparsely strigose, sparsely hirsute just above ligules; abaxial surface glabrous. **Vernation** folded. Occasional in grasslands and along roadsides and other disturberd sites, usually in sandy soils. Treated as *Chondrosum barbatum* (Lag.) W. Clayton by Shaw (2012).

20. BOUTELOUA CURTIPENDULA (Michx.) Torr. — SIDEOATS GRAMA

Plants perennial, cespitose. **Rhizomes** present or absent; **stolons** absent. **Culms** 50–100 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or hirsute externally; margins distinct, open, entire, hyaline. **Collar** continuous, glabrous; margins entire with a few papillose hairs. **Auricles** absent. **Ligules** <0.5 mm long, membranous, truncate; margins erose, ciliate. **Leaf blades** linear, 5–30 cm long, 2–7 mm wide, plane, firm-

textured; apex attenuate; margins entire with some papillose hairs basally; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Widespread and abundant in grasslands, woodland borders, and along roadsides.

21. BOUTELOUA HIRSUTA Lag. — HAIRY GRAMA

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 15–40 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally or glabrous with the lowermost sheath sparsely pilose; margins distinct, open, entire. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 5–12 cm long, 1–2 mm wide, plane or slightly involute, thin; apex attenuate; margins entire with a few papillose hairs basally; adaxial surface glabrous; abaxial surface glabrous with very few papillose hairs basally along the midnerve. **Vernation** rolled. Widespread and common in grasslands and on open, rocky slopes. Treated as *Chondrosum hirsutum* (Lag.) Kunth by Shaw (2012).

22. BOUTELOUA REPENS (Kunth) Scribn. & Merr. — SLENDER GRAMA

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–45 cm tall, erect or geniculate, weak, slender, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins entire. **Collar** continuous, glabrous; margins distinct, open, entire. **Auricles** absent. **Ligules** <0.5 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 5–16 cm long, 1–3 mm wide, plane, thin; apex acute, folded; margins entire distally, sparsely pilose with papillose hairs basally; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Primarily a south Texas species that occurs in a few Hill Country counties along roadsides or on rangeland.

23. BOUTELOUA RIGIDISETA (Steud.) Hitchc. — TEXAS GRAMA

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–50 cm tall, erect, weak, slender, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins ciliate. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 4–12(–17) cm long, 1–2 mm wide, plane or slightly involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces sparsely pilose. **Vernation** rolled. Common in grasslands, open woodlands, and along roadsides.

24. BOUTELOUA TRIFIDA Thurb. — RED GRAMA

Plants perennial, cespitose. **Rhizomes** often present on older plants, short; **stolons** absent. **Culms** 10–30(–40) cm tall, erect, wiry, often with a reddish tint, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, often with a reddish tint; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** < 0.5 mm long, a fringe of hairs. **Leaf blades** linear, 4–8 cm long, 1–1.5 mm wide, plane or conduplicate or convolute, thin; apex acute; margins entire with one or two long hairs basally, these occasionally papillose; adaxial surface glabrous with very few long hairs basally; abaxial surface glabrous. **Vernation** folded. Common on rocky hillsides, in grasslands, and disturbed sites. Treated as *Chondrosum trifidum* (Thurb.) W. Clayton by Shaw (2012).

25. BOUTELOUA UNIFLORA Vasey — NEALLEY GRAMA

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. Culms 35–50 cm tall, erect, slender, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 2–10 cm long, 1–2 mm wide, plane or involute, firm-textured; apex acute; margins entire with a few long, soft hairs; adaxial surface glabrous with a few long, soft hairs basally; abaxial surface glabrous. **Vernation** folded. Frequent in rocky, limestone soils.

26. BROMUS CATHARTICUS Vahl — RESCUEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–80 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, pilose or densely puberulent externally, rarely glabrous; margins closed to within a few centimeters of the ligules, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–5 mm long, membranous, acute; margins erose. **Leaf blades** linear, 10–30 cm long, 5–12 mm wide, plane, firm-textured, often with a yellowish band immediately above the ligule; apex acute; margins entire; adaxial and abaxial surfaces glabrous or hirsute; midnerve conspicuous abaxially. **Vernation** folded. Common and abundant in late winter and spring along roadsides, field margins, vacant lots, and other disturbed sites. Treated as *Ceratochloa cathartica* (Vahl.) Herter by Shaw (2012).

27. BROMUS JAPONICUS Thunb. — JAPANESE BROME

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–60 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** retrorsely pubescent. **Leaf sheaths** rounded, retrorsely pilose externally; margins entire. **Collar** continuous, glabrous; margins closed to within a few centimeters of the throat, entire. **Auricles** absent. **Ligules** 0.5–1.5 mm long, membranous, obtuse; margins erose or ciliate. **Leaf blades** linear, 5–15 cm long, 2–7 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces pilose or puberulent. **Vernation** rolled. Common and weedy along roadsides and in other disturbed sites.

28. BROMUS PUBESCENS Muhl. ex Willd. — CANADA BROME

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 70–140 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** pubescent. **Leaf sheaths** rounded, open, lower sheaths pilose externally, upper sheaths pubescent; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–2 mm long, membranous, truncate; margins erose, occasionally sparsely ciliate. **Leaf blades** linear, 10–30 cm long, 5–10 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous, less frequently sparsely hirsute; abaxial surface glabrous. **Vernation** rolled. Occasional along streams and in moist woodlands. Treated as *Bromopsis pubescens* (Muhl. *ex* Willd.) Holub by Shaw (2012).

29. BROMUS SECALINUS L. — RYE BROME

Plants annual, solitary or cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–90 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** retrorsely pubescent. **Leaf sheaths** rounded, glabrous or sparsely pilose externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 10–25 cm long, 3–8 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous, occasionally pilose. **Vernation** rolled. Common along roadsides and in disturbed sites.

30. BROMUS TECTORUM L. — DOWNY BROME; CHEATGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–60 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, pubescent externally; margins entire. **Collar** continuous, narrow, pubescent; margins closed to within a few centimeters of the ligules, entire. **Auricles** absent. **Ligules** 1–2.5 mm long, membranous, acute; margins erose or lacerate. **Leaf blades** linear, 5–12 cm long, 2–6 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces pubescent. **Vernation** rolled. Common on heavily grazed rangeland, along roadsides, and on other open, disturbed sites.

31. BROMUS TEXENSIS (Shear) Hitchc. — TEXAS BROME

Plants annual, solitary or cespitose. **Rhizomes** and **stolons** absent. **Culms** 40–75 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** pubescent. **Leaf sheaths** rounded, pubescent externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 10–40 cm long, 3–7 mm wide, plane, thin, soft; apex acute; margins entire; adaxial and abaxial surfaces pubescent. **Vernation** rolled. Uncommon in the shade of thickets and oak mottes. Treated as *Bromopsis texensis* (Shear) Holub by Shaw (2012).

32. BUCHLOË DACTYLOIDES (Nutt.) Engelm. — BUFFALOGRASS

Plants perennial, mat-forming. **Rhizomes** absent; stolons present with alternating elongated and bunched internodes. **Culms** 5–10 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire, hyaline. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 0.5 mm long, a fringe of hairs. **Leaf blades** linear, 2–12 (rarely –20) cm long, 1–2.5 mm wide, plane, firm-textured; apex attenuate; margins entire, occasionally with papillose hairs; adaxial surface glabrous or sparsely hispid, occasionally with papillose hairs; abaxial surfaces glabrous or sparsely hispid. **Vernation** folded. A common species in grasslands and other open sites.

33. CENCHRUS LONGISPINUS (Hack.) Fernald — LONGSPINE SANDBUR

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–90 cm tall, geniculate or decumbent, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally; margins distinct, open, pilose. **Collar** continuous, glabrous; margins ciliate. **Auricles** absent. **Ligules** 0.5–2 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 6–20 cm long, 3–7 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces scabrous. **Vernation** folded. A common species of the High Plains reported from a few Hill Country counties on disturbed sites.

34. CENCHRUS MYOSUROIDES Kunth — BIG SANDBUR

Plants perennial, solitary or forming large clusters. **Rhizomes** and **stolons** absent. **Culms** 70–200 cm tall, erect, firm, stout, glabrous, arising from a hard, knotty, subrhizomatous base. **Culm nodes** glabrous, slightly swollen. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins ciliate with hairs 1–2 mm long. **Leaf blades** linear, 12–40 cm long, 4–13 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface scabrous, occasionally sparsely pilose; abaxial surface glabrous. **Vernation** folded. Occasional along roadsides and on disturbed sites in a few Hill Country counties.

35. CENCHRUS SPINIFEX Cav. — COMMON SANDBUR

Plants annual, solitary or forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 8–80 cm tall, erect or geniculate, the outermost culms of a clump decumbent, firm, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, glabrous or sparsely pilose externally; margins distinct, open, entire, hyaline. **Collar** continuous, glabrous; margins sparsely ciliate. **Auricles** absent. **Ligules** <0.5 mm long, membranous, truncate; margins ciliate with hairs 0.5–1 mm long. **Leaf blades** linear, 2–18 cm long, 2–6 mm wide, plane, firm-textured; apex acute; margins entire or scaberulous; adaxial surface glabrous with a few long, soft hairs behind the ligules; abaxial surface glabrous. **Vernation** folded. Abundant and widespread, especially on sandy soils.

36. CHASMANTHIUM LATIFOLIUM (Michx.) H.O. Yates — CREEK-OATS

Plants perennial, cespitose. **Rhizomes** short, hard, knotty; stolons absent. **Culms** 50–150 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous, often reddish-purple. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–1 mm long, ciliate with a minute, membranous base. **Leaf blades** lanceolate, 9–20 cm long, 10–20 mm wide, plane, firm-textured; apex acuminate; margins entire; adaxial surface glabrous, sparsely pilose basally; abaxial surface glabrous. **Vernation** rolled. Widespread and abundant in moist woodlands and along shaded stream banks.

37. CHLORIS ANDROPOGONOIDES E. Fourn. — SLIMSPIKE WINDMILL-GRASS

Plants perennial, cespitose. **Rhizomes** absent; **stolons** short or absent. **Culms** 10–40 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** slightly laterally compressed laterally, weakly keeled, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long, membranous, truncate; margins erose, occasionally sparsely ciliate. **Leaf blades** linear, 5–20 cm long, 2–4 mm wide, plane, firm-textured; apex mucronate; margins entire; adaxial surface glabrous or scabrous, sparsely pilose basally; abaxial surface glabrous or scabrous. **Vernation** folded. Occasional along roadsides, in open pastures and lawns.

As noted by Barkworth et al. (2007), *C. andropogonoides*, *C. cucullata*, and *C. verticillata* often form mixed populations in central Texas that include many apparent hybrids and introgressants that combine the morphological characteristics of their parents, making assignment to one species difficult. These plants were recognized as *C. subdolichostachya* Muller by Gould (1975).

38. CHLORIS CUCULLATA Bisch. — HOODED WINDMILL-GRASS

Plants perennial, cespitose. **Rhizomes** absent; stolons short or absent. **Culms** 15–60 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally; margins distinct, open, entire, wide, papery. **Collar** continuous, glabrous, yellowish; margins entire. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 3–20 cm long, 2–4 mm wide, tightly conduplicate, firm-textured; apex obtuse; margins entire; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** folded. Common and widespread along roadsides and other disturbed sites, especially on sandy soils.

See the discussion of hybridization under *C. andropogonoides*.

39. CHLORIS VERTICILLATA Nutt. — TUMBLE WINDMILL-GRASS

Plants perennial, cespitose. Rhizomes and stolons absent. Culms 15–50 cm tall, erect or geniculate or decumbent; firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally; margins distinct, open, entire, hyaline. **Collar** divided, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, truncate; margins ciliate, often with a few long hairs at the edges. **Leaf blades** linear, 2–15 cm long, 1–3 mm wide, conduplicate, firm-textured; apex obtuse or mucronate; margins entire, often whitish; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** folded; along roadsides, lawns, parks and disturbed sites in heavy sand or gravelly soils.

See the discussion of hybridization under *C. andropogonoides*.

40. CHLORIS VIRGATA Sw. — FEATHER WINDMILL-GRASS; SHOWY CHLORIS

Plants annual, cespitose. **Rhizomes** absent; **stolons** short or absent. **Culms** 50–100 cm tall, geniculate or decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous; leaf sheath rounded, keeled, glabrous externally, occasionally pilose near the throat; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 10–30 cm long, 2–6 mm wide, plane or conduplicate, firm-textured; apex obtuse or mucronate; margins entire, sparsely villous basally; adaxial surface glabrous, sparsely villous basally; abaxial surface glabrous. **Vernation** folded. Common and widespread on disturbed sites, especially along roadsides.

41. COELORACHIS CYLINDRICA (Michx.) Nash — CAROLINA JOINT-TAIL

Plants perennial, solitary or forming small clusters. **Rhizomes** short, knotty; **stolons** absent. **Culms** 30–100 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, weakly keeled, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins erose, ciliate. **Leaf blades** linear, 8–30 cm long, 1.5–4 mm wide, plane or conduplicate, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous; midnerve and some secondary nerves conspicuous, scabrous. **Vernation** folded. Infrequent in grasslands and along woodland margins.

42. CYNODON DACTYLON (L.) Pers. — BERMUDAGRASS

Plants perennial, mat-forming. **Rhizomes** present, elongate; **stolons** present. **Culms** 10–50 cm tall, geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaves** distichous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, narrow, glabrous; margins entire with a few long hairs. **Auricles** absent. **Ligules** <0.5 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 3–8(–14) cm long, 1–3(–4) mm wide, plane or conduplicate, firm-textured, often glaucous; apex obtuse; margins entire; adaxial surface glabrous or scabrous; abaxial surface glabrous. **Vernation** rolled. Common and widespread in lawns and pastures, frequent along roadsides and on other disturbed sites.

43. DACTYLOCTENIUM AEGYPTIUM (L.) Willd. — DURBAN CROWFOOTGRASS

Plants usually annual, cespitose, or less often perennial and mat-forming. **Rhizomes** absent; **stolons** absent or present. **Culms** 10–60 cm tall, erect or geniculate, the outermost culms of a clump decumbent, weak, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes**

glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally, occasionally with a few papillose hairs on the keel just below the collar; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** ±0.5 mm long, membranous, truncate; margins sparsely ciliate. **Leaf blades** linear, 3–25 cm long, 2–8 mm wide, plane or conduplicate, firm-textured; apex acuminate; margins pilose with papillose hairs; adaxial and abaxial surfaces glabrous. **Vernation** folded. Common on disturbed sites in a few Hill Country counties.

44. DESMAZERIA RIGIDA (L.) Tutin — FERN GRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 4–10(–18) cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire, upper margins thin, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1.5–4 mm long, membranous, decurrent on either side as sheath margins, obtuse; margins lacerate. **Leaf blades** linear, 2–8(–12) cm long, 1–4 mm wide, plane, soft; apex acute; margins entire; adaxial surface glabrous or scabrous; abaxial surface glabrous. **Vernation** folded. Occasional along roadsides, in lawns, and on disturbed sites in the eastern Hill Country.

45. DICHANTHELIUM ACUMINATUM (Sw.) Gould & C.A. Clark — HAIRY PANICGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–70(–90) cm tall, erect, firm, distally pubescent, not swollen at the base. **Culm nodes** pubescent. **Leaf sheaths** rounded, glabrous or pilose externally; margins distinct, open, pubescent or ciliate. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–4(–6) mm long, a fringe of hairs, typically with a band of short hairs below a band of long hairs or the long hairs restricted to the sides of the band of short hairs. **Leaf blades** linear, 3–9(–15) cm long, 5–12 mm wide, plane, firm-textured; apex acute; margins entire, glabrous or ciliate; adaxial and abaxial surfaces pilose or hispid, less frequently glabrous. **Vernation** rolled. A common but variable species that occurs in a wide variety of habitats.

No attempt has been made to distinguish vegetatively among the four subspecies recognized by Shaw (2012).

46. DICHANTHELIUM OLIGOSANTHES (Schult.) Gould — FEW-FLOWERED PANICGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 15–84 cm tall, erect, firm, glabrous to densely puberulent, not swollen at the base. **Culm nodes** pubescent. **Leaf sheaths** rounded, pilose with papillose hairs, occasionally glabrous; margins distinct, open, ciliate. **Collar** continuous, glabrous, less frequently pubescent; margins entire, occasionally sparsely villous. **Auricles** absent. **Ligules** 1–4 mm long, a fringe of hairs. **Leaf blades** lanceolate, 3–14 cm long, 3–12(–15) mm wide, plane, firm-textured; apex acute; margins entire with few papillose hairs; adaxial surface glabrous; abaxial surface glabrous or puberulent, occasionally tomentose. **Vernation** rolled. Common in a variety of habitats. Treated as *Panicum oligosanthes* Schult. by Correll and Johnston (1970).

47. DICHANTHELIUM PEDICELLATUM (Vasey) Gould — CEDAR PANICGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–70 cm tall, erect or geniculate, firm, distally puberulent, arising from a hard, knotty base. **Culm nodes** pubescent. **Leaf sheaths** rounded, glabrous or pilose externally; margins distinct, open, entire, ciliate near the throat. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long, ciliate with a minute, membranous base. **Leaf blades** lanceolate, 4–12 cm long, 3–8 mm wide, plane, firm-

textured; apex acuminate; margins entire; adaxial surface glabrous or sparsely pilose with appressed hairs, typically with a few papillose hairs basally; abaxial surface glabrous or sparsely pilose with appressed hairs. **Vernation** rolled. Occasional on limestone slopes and in oak woodlands. Treated as *P. pedicellatum* Vasey by Correll and Johnston (1970).

48. DICHANTHELIUM SPHAEROCARPON (Ell.) Gould — ROUND-FRUITED PANICGRASS

Plants perennial, solitary or forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 20–80 cm tall, geniculate or decumbent, firm, glabrous, not swollen at the base. **Culm nodes** antrorsely pubescent. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, pubescent. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** absent or if present, to 1 mm long and ciliate. **Leaf blades** lanceolate, cordate at the base, 3–7 cm long, 7–14 mm wide, plane, firm-textured; apex acute; margins entire, undulate, cartilaginous, whitish, ciliate basally; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Primarily an east Texas species but occurring on dry, open sites and along roadsides in a few Hill Country counties. Treated as *Panicum sphaerocarpon* Elliott by Correll and Johnston (1970).

49. DICHANTHIUM ANNULATUM (Forssk.) Stapf — KLEBERG BLUESTEM

Plants perennial, cespitose. **Rhizomes** absent; **stoloniferous culms** often present. **Culms** 70–100 cm tall, erect or decumbent, firm, glabrous, not swollen at the base. **Culm nodes** pubescent. **Leaf sheaths** rounded, shorter than the adjacent culm internodes, glabrous externally; margins distinct, open, entire. **Collar** continuous, sparsely pubescent; margins entire. **Auricles** absent. **Ligules** ±1 mm long, membranous, hyaline; margins; margins erose. **Leaf blades** linear, 6–25 cm long, 3–6 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous or sparsely hispid with papillose hairs; abaxial surface glabrous. **Vernation** rolled. Occasional along roadsides and in pastures in the eastern Hill Country counties.

50. DIGITARIA CALIFORNICA (Benth.) Henrard — CALIFORNIA COTTONTOP

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100 cm tall, erect, firm, glabrous, arising from a hard, knotty, subrhizomatous base covered with densely pubescent, scale-like leaves. **Culm nodes** glabrous. **Leaf sheaths** rounded, lower sheaths villous externally, upper sheaths glabrous or sparsely pubescent externally; margins distinct, open, lower sheath margins entire, upper sheath margins sparsely ciliate. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–3 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 2–12 cm long, 2–5 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** folded. Common along roadsides and in open grasslands.

We have found no vegetative characters that can be used to reliably distinguish among *D. californica*, *D. insularis*, and *D. patens*.

51. DIGITARIA CILIARIS (Retz.) Koeler — SOUTHERN CRABGRASS

Plants annual, mat-forming. **Rhizomes** and **stolons** absent. **Culms** 10–30 cm tall, decumbent or prostrate, weak, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** rounded, keeled, pilose externally with papillose hairs; margins distinct, open, entire. **Collar** continuous, occasionally divided, glabrous; margins pilose. **Auricles** absent. **Ligules** 0.5–2.5 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 3–10 cm long, 5–10 mm wide, plane, firm-textured; apex acute; margins entire, undulate, white-colored; adaxial and abaxial surfaces glabrous or sparsely pilose with papillose hairs. **Vernation** rolled. A

common and widespread species of disturbed sites.

We have found no vegetative characters that can be used to reliably distinguish between *D. ciliaris* and *D. sanguinalis*.

52. DIGITARIA COGNATA (Schult.) Pilg — FALL WITCHGRASS

Plants perennial, solitary or forming small clumps. **Rhizomes** present or absent; **stolons** absent. **Culms** 30–80 cm tall, erect, firm, glabrous, arising from a hard, knotty, subrhizomatous base. **Culm nodes** glabrous. **Leaf sheaths** rounded, pilose externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** ±0.5 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 2–8 cm long, 2–6 mm wide, plane, firm-textured; apex acute; margins entire, undulate; adaxial surface sparsely pubescent, sparsely pilose basally; abaxial surface, sparsely pubescent. **Vernation** rolled. Common on dry, rocky or sandy soils. Treated as Leptoloma cognatum (Schult.) Chase by Correll and Johnston (1970) and Gould (1975).

As circumscribed here, *D. cognata* includes *D. pubiflora* (Vasey) Wipff, which was recognized by Shaw (2012). The taxa cannot be distinguished vegetatively.

53. DIGITARIA INSULARIS (L.) Mez ex Ekman — SOURGRASS

Plants perennial, cespitose. **Rhizomes** present, short, forming a hard, knotty base; **stolons** absent. **Culms** 70–150 cm tall, erect, firm, glabrous. **Culm nodes** glabrous. **Leaf sheaths** rounded, lower sheaths pubescent externally, upper sheaths glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–3 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 12–40 cm long, 4–10 mm wide, plane, firm-textured; apex acuminate; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Occasional along ditches and in moist or wet depressions in a few Hill Country counties.

We have found no vegetative characters that can be used to reliably distinguish among *D. californica*, *D. insularis,* and *D. patens.*

54. DIGITARIA PATENS (Swallen) Henrard — TEXAS COTTONTOP

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 40–90 cm tall, erect, firm, glabrous, arising from a hard, knotty base covered with densely pubescent, scale-like leaves. **Culm nodes** glabrous. **Leaf sheaths** rounded, pubescent externally; margins distinct, open, entire or sparsely ciliate. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–4 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 4–12 cm long, 2–3 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** folded. Occasional on disturbed sites, usually over sandy soils.

We have found no vegetative characters that can be used to reliably distinguish among *D. californica*, *D. insularis,* and *D. patens.*

55. DIGITARIA SANGUINALIS (L.) Scop. — HAIRY CRABGRASS

Plants annual, mat-forming. **Rhizomes** and **stolons** absent. **Culms** 10–30 cm tall, decumbent or prostrate, weak, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** rounded, keeled, pilose externally with papillose hairs; margins distinct, open, entire. **Collar** continuous, occasionally divided, glabrous; margins pilose. **Auricles**

absent. **Ligules** 0.5–2.5 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 3–10 cm long, 5–10 mm wide, plane, firm-textured; apex acute; margins entire, undulate, white-colored; adaxial and abaxial surfaces glabrous with a few basal papillose hairs or wholly pilose with papillose hairs. **Vernation** rolled. Common on disturbed sites and in lawns and gardens, especially in the eastern Hill Country counties.

We have found no vegetative characters that can be used to reliably distinguish between *D. ciliaris* and *D. sanguinalis*.

56. ECHINOCHLOA COLONA (L.) Link — JUNGLE RICE; AWNLESS BARNYARD GRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–70 cm tall, erect or geniculate; or decumbent, weak, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** slightly laterally compressed laterally, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** absent. **Leaf blades** linear, 5–30 cm long, 3–6(–9) mm wide, plane, thin, often colored with purple bands, V-shaped markings, or blotches; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common weedy grass of ditches, lawns, gardens and other moist, disturbed sites.

57. ECHINOCHLOA CRUS-GALLI (L.) P. Beauv. — BARNYARD GRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. Culms 30–100(–200) cm tall, erect or geniculate, the outermost culms of a tuft decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous, slightly swollen. **Leaf sheaths** slightly laterally compressed laterally, glabrous externally; margins distinct, open, entire. **Collar** continuous, wide, glabrous; margins entire. **Auricles** absent. **Ligules** absent. **Leaf blades** linear, 10–40 cm long, 5–25 mm wide, plane or V-shaped, firm-textured; apex acute; margins serrulate, sparsely pilose near base, often undulate; adaxial surface glabrous, occasionally sparsely hirsute; abaxial surface glabrous. **Vernation** rolled. A common weedy species of moist, disturbed sites.

58. ECHINOCHLOA CRUS-PAVONIS (Kunth) Schult. — GULF COAST BARNYARD GRASS

Plants annual, solitary or forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 30–100(–200) cm tall, geniculate or decumbent, firm, stout, glabrous, not swollen at the base. **Culm nodes** glabrous, slightly swollen. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** absent. **Leaf blades** linear, 15–40 cm long, 7–20 mm wide, plane, firm-textured, green or purplish; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common in roadside ditches and other wet, disturbed sites.

59. ELEUSINE INDICA (L.) Gaertn. — GOOSEGRASS

Plants annual, cespitose. **Rhizomes** absent; **stolons** occasionally present. **Culms** 15–70 cm tall, erect or geniculate, the outermost culms of a clump decumbent, firm, slightly compressed, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous or sparsely villous externally; margins distinct, open, entire, often sparsely hispid basally. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins entire or lacerate. **Leaf blades** linear, 5–35 cm long, 3–8 mm wide, plane or conduplicate, keeled at the base, firm-textured; apex obtuse; margins entire, occasionally sparsely villous; adaxial surface glabrous, occasionally sparsely villous basally; abaxial surface glabrous. **Vernation** rolled. Common on disturbed sites.

60. ELYMUS CANADENSIS L. — CANADA WILDRYE

Plants perennial, cespitose. **Rhizomes** short or usually absent; **stolons** absent. **Culms** 80–150 cm tall, typically decumbent, firm, tough, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, occasionally pilose; margins distinct, open, antrorsely ciliate. **Collar** continuous, broad, glabrous; margins entire. **Auricles** present on both sides, to 2.5 mm long. **Ligules** 0.5–1 mm long, membranous, truncate; margins entire. **Leaf blades** linear, 15–40 cm long, 4–12 mm wide, plane or conduplicate, firm-textured; apex attenuate; margins entire; adaxial surface glabrous, scabrous, or pubescent; abaxial surface glabrous. **Vernation** rolled. Common in woodlands and other shaded sites and along stream banks.

61. ELYMUS VIRGINICUS L. — VIRGINIA WILDRYE

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 60–120 cm tall, erect or geniculate, occasionally decumbent, firm, tough, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, occasionally pilose; margins distinct, open, entire. **Collar** continuous, broad, glabrous, often purplish; margins entire. **Auricles** present, to 3.0 mm long. **Ligules** 0.5–1 mm long, membranous; margins truncate, erose, ciliolate. **Leaf blades** linear, 10–30 cm long, 5–15 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous, scabrous, or pubescent; abaxial surface glabrous. **Vernation** rolled. Widespread in woodlands and grasslands. Plants referred to *E. glabriflorus* (Vasey ex L.H. Dewey) Scribn. & C.R. Ball and *E. macgregorii* R. Brooks & J.J.N. Campb. by Shaw (2012) will key out here.

62. ERAGROSTIS BARRELIERI Daveau — MEDITERRANEAN LOVEGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–55 cm tall, geniculate or decumbent, firm, glabrous, usually with a yellowish band of glandular tissue just below each node, not swollen at the base. **Culm nodes** glabrous, branched at the lower nodes. **Leaf sheaths** rounded, shorter than the adjacent culm internodes, glabrous externally; margins distinct, open, entire. **Collar** continuous, pilose; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 3–10 cm long, 1–5 mm wide, plane, firm-textured; apex acute, involute; margins entire; adaxial and abaxial surfaces glabrous or sparsely pilose. **Vernation** folded. Widespread along roadsides and on disturbed sites.

63. ERAGROSTIS CILIANENSIS (All.) Vignolo ex Janch. — STINKGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–60 cm tall, erect or geniculate, firm, glabrous, usually with a ring of glands just below each node, not swollen at the base, freely branched at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, weakly keeled, shorter than the adjacent culm nodes, glabrous externally, usually with glands on the keel and some of the other nerves; margins distinct, open, entire. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** to 1 mm long, a fringe of hairs. **Leaf blades** linear, 10–20 cm long, 2.5–7 mm wide, plane or V-shaped, firm-textured; apex acute; margins entire or pilose with papillose hairs; adaxial surface glabrous with glands on the midnerve; abaxial surface glabrous; midnerve conspicuous, white. **Vernation** rolled. Widespread along roadsides and on disturbed sites.

64. ERAGROSTIS CURTIPEDICELLATA Buckley — GUMMY LOVEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–60 cm tall, erect or geniculate, firm, glabrous, viscid, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or pilose externally, often viscid; margins distinct, overlapping, entire, occasionally

one or both margins ciliate. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 5–10 cm long, 2–4 mm wide, plane or involute, typically bending sharply (±90°) away from the culm, firm-textured; apex attenuate; margins entire; adaxial surface glabrous, sparsely villous immediately above the ligules; abaxial surface glabrous. **Vernation** rolled. Along roadsides, field margins, and openings in oak woodlands.

65. ERAGROSTIS CURVULA (Schrad.) Nees — WEEPING LOVEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 75–150 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, keeled, shorter than the adjacent culm internodes, glabrous externally, the lowest sheaths hispid; margins distinct, open, entire. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 0.5–1 mm long, a fringe of hairs. **Leaf blades** linear or filiform, 20–30 cm long, 1–1.5 mm wide, involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces scabrous. **Vernation** rolled. Occasional along roadsides and in fields.

66. ERAGROSTIS INTERMEDIA Hitchc. — PLAINS LOVEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–90 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, inner margins entire, outer margins ciliate, occasionally both margins ciliate. **Collar** continuous, pilose; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 15–20 cm long, 2–3 mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial surface glabrous, sparsely hirsute at the base and behind the ligules; abaxial surface glabrous. **Vernation** rolled. Widespread in grasslands, along roadsides, and in other disturbed sites.

67. ERAGROSTIS LUGENS Nees — MOURNING LOVEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 35–70 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, overlapping, entire. **Collar** continuous, glabrous; margins hirsute. **Auricles** absent. **Ligules** ±1 mm long, a fringe of hairs. **Leaf blades** linear, 8–20 cm long, 1–2 mm wide, involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Primarily a species of snady soils in the coastal plain; found in a few Hill Country counties.

68. ERAGROSTIS PECTINACEA (Michx.) Nees ex Steud. — SPREADING LOVEGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–55 cm tall, erect or geniculate, the outermost culms of a clump decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, weakly keeled, shorter than the adjacent culm internodes, glabrous externally; margins entire. **Collar** continuous, glabrous; margins distinct, open, pilose. **Auricles** absent. **Ligules** <0.5 mm, ciliate. **Leaf blades** linear or lanceolate, 8–18 cm long, 3–7 mm wide, plane or conduplicate, firm-textured; apex acute; margins entire; adaxial surface scabrous; abaxial surface glabrous. **Vernation** rolled. Occasional along roadsides and in fields and gardens.

69. ERAGROSTIS REPTANS (Michx.) Nees — CREEPING LOVEGRASS

Plants annual, mat-forming. **Rhizomes** and **stolons** absent. **Culms** 5–10(–20) cm tall, decumbent or prostrate, wiry, pubescent, less frequently glabrous, not swollen at the base, often

rooting at the lower nodes. **Culm nodes** pubescent. **Leaf sheaths** rounded, shorter than the adjacent culm internodes, pubescent externally, less frequently glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 1–4 cm long, 1–2 mm wide, plane or conduplicate, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces pubescent, less frequently glabrous. **Vernation** rolled. Occasional along the margins of ponds and streams and marshy sites, often frequent and abundant on the exposed beds following periods of drought, mostly along the eastern and southern margins of the Hill Country. Treated as *Neeragrostis reptans* (Michx.) Nicora in Gould (1975).

70. ERAGROSTIS SECUNDIFLORA J. Presl — RED LOVEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–75 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, overlapping, entire, occasionally the outer margins or both margins pilose. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 10–15 cm long, 2–2.5 mm wide, plane or involute, firm-textured; apex acute; margins entire; adaxial surface glabrous with a few long, soft hairs basally; abaxial surface glabrous. **Vernation** rolled. Common on sandy, disturbed soils.

We have found no vegetative characters that can be used to reliably distinguish between this taxon and *E. trichodes*.

71. ERAGROSTIS SPECTABILIS (Pursh) Steud. — PURPLE LOVEGRASS

Plants perennial, cespitose. **Rhizomes** short, knotty; **stolons** absent. **Culms** 40–75 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, pilose externally; margins distinct, overlapping, entire, occasionally the outer margin or both margins pilose. **Collar** continuous, pilose; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 15–40 cm long, 3–7 mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial surface glabrous or pilose, often glabrous, pilose basally; abaxial surface glabrous or pilose. **Vernation** rolled. Occasional along roadsides, in abandoned fields, and woodland openings, usually on sandy soil.

72. ERAGROSTIS SUPERBA Peyr. — WILMANN LOVEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–120 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, pilose. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long, a fringe of hairs. **Leaf blades** linear, 10–40 cm long, 2–10 mm wide, plane or involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common along roadsides and in pastures and occasional in oak woodlands in a few Hill Country counties.

73. ERAGROSTIS TRICHODES (Nutt.) Alph. Wood — SAND LOVEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 70–110 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, occasionally hirsute; margins distinct, overlapping, entire, occasionally villous. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 15–40 cm long, 1–8 mm wide, plane with an involute tip, firm-textured; apex

acute; margins entire; adaxial surface glabrous, sparsely hirsute at the base; abaxial surface glabrous. **Vernation** rolled. Common in grasslands and open woodlands over sandy soil.

We have found no vegetative characters that can be used to reliably distinguish between this taxon and *E. secundiflora*.

74. ERIOCHLOA CONTRACTA Hitchc. — PRAIRIE CUPGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–70 cm tall, erect or geniculate, firm, glabrous or puberulent, not swollen at the base. **Culm nodes** puberulent. **Leaf sheaths** rounded, puberulent externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 3–20 cm long, 2–7 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces puberulent. **Vernation** rolled. Occasional in fields, roadsides, and other disturbed sites.

75. ERIOCHLOA SERICEA (Scheele) Munro ex Vasey — TEXAS CUPGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100 cm tall, erect, firm, pubescent, not swollen at the base. **Culm nodes** antrorsely pubescent with very short hairs. **Leaf sheaths** rounded, pubescent externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 10–30 cm long, 2–3 mm wide, plane or involute, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces pubescent, less frequently glabrous. **Vernation** rolled. Common in grasslands and oak-juniper woodlands throughout the Hill Country.

76. ERIONEURON PILOSUM (Buckley) Nash — HAIRY TRIDENS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–30 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, keeled, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 2–8(–11) cm long, 1–2 mm wide, plane, often conduplicate, firm-textured; apex abruptly acute, hardened; margins entire, cartilaginous, white-colored; adaxial surface glabrous, occasionally antrorsely pilose; abaxial surface glabrous; midnerve conspicuous abaxially, white-colored. **Vernation** folded. Widespread and frequent on rocky hillsides, in oak-juniper woodlands, and along roadsides.

77. FESTUCA VERSUTA Beal — TEXAS FESCUE

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins entire. **Leaf blades** linear, 10–40 long, 2–5 mm wide, plane or loosely folded, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Uncommon in shaded woodlands along the eastern margin of the Hill Country.

78. GLYCERIA STRIATA (Lam.) Hitchc. — FOWL MANNAGRASS

Plants perennial, cespitose. **Rhizomes** short or absent; **stolons** absent. **Culms** 40–90 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded,

glabrous or scaberulous externally; margins closed to within a few centimeters of the ligules, entire. **Collar** continuous, often inconspicuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1.5–4 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 5–25 cm long, 2–8 mm wide, plane or V-shaped, firm-textured; apex obtuse, often prow-shaped; margins entire; adaxial surface glabrous, often scaberulous, median lines present; abaxial surface glabrous. **Vernation** folded. Occasional along stream margins and ponds.

79. HETEROPOGON CONTORTUS (L.) P. Beauv. — TANGLEHEAD

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–80 cm tall, erect, firm, glabrous, not swollen at the base, lateral branches basally fastigiate. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally, occasionally sparsely villous; margins distinct, open, entire. **Collar** continuous, glabrous; margins sparsely villous. **Auricles** absent. **Ligules** to 1 mm long, membranous, often brown-colored, truncate; margins ciliate. **Leaf blades** linear, 6–20 cm long, 4–6(–10) mm wide, plane, occasionally conduplicate, firm-textured; apex acute; margins entire, often sparsely pilose basally with papillose hairs; adaxial and abaxial surfaces glabrous. **Vernation** folded. Locally common in grasslands and on rocky slopes, usually on sandy soil.

80. HILARIA BELANGERI (Steud.) Nash — CURLYMESQUITE

Plants perennial, cespitose. **Rhizomes** absent; **stolons** wiry. **Culms** 10–30 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** villous, the lower nodes densely so. **Leaf sheaths** rounded, glabrous externally; margins distinct, overlapping, entire. **Collar** continuous, glabrous; margins entire, often with 1 or 2 long hairs on both sides. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, obtuse or truncate; margins lacerate. **Leaf blades** linear, 5–20 cm long, 1–3 mm wide, plane or arcuate, firm-textured; apex acuminate; margins entire; adaxial and abaxial surfaces glabrous or sparsely pilose with papillose hairs. **Vernation** rolled. Widespread in grasslands.

81. HILARIA MUTICA (Buckley) Benth. — TOBOSAGRASS

Plants perennial, cespitose. **Rhizomes** short, thick, scaly; **stolons** absent. **Culms** 30–70 cm tall, erect, wiry, glabrous, not swollen at the base. **Culm nodes** pubescent. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, ciliate toward the ligule. **Collar** continuous, glabrous; margins villous. **Auricles** absent. **Ligules** 1–2 mm long, membranous, obtuse or truncate; margins lacerate. **Leaf blades** linear, 5–10 cm long, 2–5 mm wide, plane or involute, firm-textured to somewhat stiff; apex acute; margins entire; adaxial surface glabrous or scabrous, typically with a few long hairs at the base immediately above the ligule; abaxial surface glabrous or scabrous. **Vernation** rolled. A west Texas species occurring in open grasslands in a few southern and western Hill County counties. Treated as *Pleuraphis mutica* Buckley by Shaw (2012).

82. HOPIA OBTUSA (Kunth) Zuloaga & Morrone — VINE MESQUITE

Plants perennial. **Rhizomes** absent; **stolons** elongate, wiry, with swollen, villous nodes. **Culms** 20–60 cm tall, erect, firm, glabrous, arising from a hard, knotty base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, occasionally hispid; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire, occasionally sparsely pilose. **Auricles** absent. **Ligules** 1–2 mm long, membranous, obtuse; margins entire or lacerate. **Leaf blades** linear, 5–20 cm long, 2–7 mm wide, plane or involute, firm-textured, glaucous; apex attenuate; margins entire; adaxial surface glabrous, often sparsely pilose basally; abaxial surface glabrous. **Vernation** rolled. Widespread on

stream banks, in roadside ditches, and in moist depressions on rangeland. Treated as *Panicum obtusum* Kunth by Correll and Johnston (1970) and Gould (1975).

83. HORDEUM MURINUM L. — SMOOTH BARLEY

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 15–60 cm tall, erect or geniculate, thick, succulent, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or sparsely hispid externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** present, to 2 mm long. **Ligules** 0.5–1 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 6–15 cm long, 3–8 mm wide, plane, weak; apex acute; margins entire; adaxial surface glabrous or hispid; abaxial surface glabrous. **Vernation** folded. Uncommon as a weed of disturbed sites in the Hill Country. Treated as *Critesion murinum* (L.) Á. Löve by Shaw (2012).

84. HORDEUM PUSILLUM Nutt. — LITTLE BARLEY

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–40 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, pubescent externally, less frequently glabrous; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent or, when present, minute, <1 mm long. **Ligules** <0.5 mm long, membranous, truncate; margins entire. **Leaf blades** linear, 3–12 cm long, 2–4(–5) mm wide, plane or U-shaped, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces pubescent, occasionally glabrous. **Vernation** rolled. Widespread and abundant along roadsides and in other disturbed areas. Treated as *Critesion pusillum* (Nutt.) Á. Löve by Shaw (2012).

85. HORDEUM VULGARE L. — BARLEY

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–120 cm tall, erect, thick, succulent, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** present, ±2 mm long. **Ligules** 1–3 mm long, membranous, truncate; margins entire. **Leaf blades** linear, 10–45 cm long, 5–15 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface scabrous; abaxial surface glabrous. **Vernation** rolled. Occasionally found as an escape from cultivation.

86. LEERSIA ORYZOIDES (L.) Sw. — RICE CUTGRASS

Plants perennial, cespitose. **Rhizomes** slender, elongate, not scaly; **stolons** absent. **Culms** 80–150 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** retrorsely pubescent. **Leaf sheaths** rounded, retrorsely scabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous or sparsely pubescent; margins entire, occasionally sparsely pubescent. **Auricles** absent. **Ligules** 0.5–2 mm long, membranous, firm-textured, truncate; margins erose. **Leaf blades** linear; 8–30 cm long, 7–10 mm wide, plane, firm-textured; apex acute; margins serrate; adaxial and abaxial surfaces retrorsely scabrous; midnerve serrate abaxially. **Vernation** rolled. Occasional in saturated soils along Hill Country streams.

87. LEPTOCHLOA DUBIA (Kunth) Nees — GREEN SPRANGLETOP

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–110 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, the lowermost sheaths compressed, keeled and pilose externally; margins distinct, open, entire. **Collar** continuous, glabrous, occasionally sparsely pubescent; margins entire. **Auricles**

absent. **Ligules** <0.5 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 5–30 cm long, 2–6(–8) mm wide, plane, becoming involute upon drying, firm-textured, glaucous; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous or sparsely pilose. **Vernation** folded. Common in grasslands and on rockly slopes.

88. LEPTOCHLOA FUSCA (L.) Kunth — BEARDED SPRANGLETOP

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100 cm tall, erect or geniculate, the outermost culms of a clump decumbent, firm, somewhat succulent, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, the lowermost weakly keeled, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–6 mm long, membranous, hyaline, acute; margins lacerate, with lateral lobes resembling auricles. **Leaf blades** linear, 5–35 cm long, 2–7 mm wide, plane or involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces glabrous or sparsely hispid. **Vernation** rolled. Occasional along stream and pond margins. Includes plants treated as *L. fascicularis* (Lam.) A. Gray and *L. uninervia* (J. Presl) Hitchc. & Chase by Correll and Johnston (1970) and Gould (1975).

89. LEPTOCHLOA PANICEA (Retz.) Ohwi — RED SPRANGLETOP

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–80 cm tall, decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, pilose externally with papillose hairs; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, truncate; margins erose, occasionally sparsely ciliate. **Leaf blades** linear, 2–20 cm long, 1–10 mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces pilose, often with papillose hairs basally. **Vernation** rolled. A common weedy species of disturbed sites. Treated as *L. filiformis* (Lam.) P. Beauv. by Correll and Johnston (1970) and Gould (1975).

90. LIMNODEA ARKANSANA (Nutt.) L.H. Dewey — OZARKGRASS

Plants annual, solitary or forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 20–60 cm tall, erect, weak, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or hispid externally; margins distinct, open, entire. **Collar** continuous, oblique, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, obtuse; margins lacerate. **Leaf blades** linear, 3–12 cm long, 2–8 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces hispid, less frequently glabrous. **Vernation** folded. Common in open woodlands and riparian areas.

91. LOLIUM PERENNE L. — PERENNIAL RYEGRASS

Plants annual or short-lived perennials, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–70 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, reddish at the base, glabrous externally; margins distinct, open, entire, the upper margins thin, hyaline. **Collar** continuous, narrow, glabrous; margins entire. **Auricles** present, to 5 mm long. **Ligules** 0.5–1.5 mm long, membranous, decurrent on both sides, obtuse; margins entire. **Leaf blades** linear, 5–20 cm long, 2–10 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** folded. Common and widespread as an escape on disturbed sites.

92. LOLIUM TEMULENTUM L. — DARNEL RYEGRASS

Plants annual, solitary or cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–70 cm tall, erect or decumbent, weak, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, narrow, glabrous; margins entire. **Auricles** present, to 1 mm long. **Ligules** 0.5–1 mm long, membranous, truncate; margins lacerate. **Leaf blades** linear, 6–40 cm long, 2–8 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Occasional on disturbed sites and along roadsides.

93. MELICA NITENS (Scribn.) Nutt. ex Piper — THREE-FLOWER MELIC

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–120 cm tall, erect, firm, glabrous, arising from a hard, subrhizomatous base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or scabrous externally, occasionally puberulent externally; margins closed to within a few millimeters of the throat, entire, upper margins thin, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 3–6 mm long, membranous, decurrent on both sides, truncate; margins erose or lacerate. **Leaf blades** linear, 10–30 cm long, 3–10(–15) mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces glabrous or scabrous, occasionally puberulent. **Vernation** rolled. Common in open woodlands and canyons.

94. MUHLENBERGIA ARENACEA (Buckley) Hitchc. — EAR MUHLY

Plants perennial, mat-forming. **Rhizomes** slender; **stolons** absent. **Culms** 10–20(–40) cm tall, decumbent, firm, glabrous, striate, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, shorter than the adjacent internodes, glabrous externally; margins distinct, open, entire, upper margins thin, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 1 mm long with lateral extensions 1–2 mm long appearing as erect auricles, membranous, decurrent on either side, truncate; margins erose or lacerate. **Leaf blades** linear, 1–3(–6) cm long, 0.5–1.5 mm wide, plane or conduplicate or involute, often twisted, firm-textured; apex attenuate; margins entire or scabrous, cartilaginous, white-colored; adaxial and abaxial surfaces glabrous; midnerve conspicuous, whitish. **Vernation** folded. Primarily a species of west Texas but occasional in open grasslands along the eastern margin of the Hill Country.

95. MUHLENBERGIA LINDHEIMERI Hitchc. — LINDHEIMER MUHLY

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100(–150) cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, the lower sheaths laterally compressed and keeled, glabrous externally; margins distinct, open, entire, upper margins thin, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 8–15 mm long, membranous, firm and brown at the base, decurrent on both sides, acute; margins lacerate. **Leaf blades** linear, 10–45(–50) cm long, 2–3(–5) mm wide, conduplicate, firm-textured, pale green or glaucous; apex acute, involute upon on drying; margins entire; adaxial surface glabrous or scabrous, occasionally sparsely pubescent; abaxial surface glabrous or scabrous. **Vernation** folded. Common on seepage slopes, in canyons, and along moist roadsides.

96. MUHLENBERGIA PORTERI Scribn. ex Beal — BUSH MUHLY

Plants perennial, solitary or forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 30–100 cm tall, decumbent, wiry, glabrous, occasionally puberulent just below the nodes, arising

from a hard, knotty base. **Culm nodes** numerous, glabrous. **Leaf sheaths** rounded, shorter than the adjacent internodes, glabrous externally; margins distinct, open, entire, upper margins thin, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2.5 mm long, membranous, decurrent on either side as sheath margins, truncate; margins lacerate. **Leaf blades** linear, 2–5 cm long, 0.5–2 mm wide, plane or involute, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces scabrous. **Vernation** folded. A west Texas species with sporadic occurrence on rocky slopes in the Hill Country.

97. MUHLENBERGIA REVERCHONII Vasey & Scribn. — SEEP MUHLY

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 40–80 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, scaberulous externally; margins distinct, open, entire. **Collar** continuous, often inconspicuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–9 mm long, membranous, firm at the base, hyaline distally, acute; margins lacerate. **Leaf blades** filiform, arcuate, 8–35 cm long, 1–2 mm wide, involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces scaberulous. **Vernation** folded. Common on rocky slopes, often in association with seepage areas.

98. MUHLENBERGIA SCHREBERI Gmel. — NIMBLEWILL

Plants perennial, solitary or forming small clusters. Rhizomes absent; stolons often present, short. **Culms** 10–40(–60) cm tall, decumbent, firm, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** rounded, shorter than the adjacent internodes, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire, sparsely ciliate. **Auricles** absent. **Ligules** <0.5 mm long, membranous, truncate; margins erose or lacerate, ciliate. **Leaf blades** linear, 3–8 cm long, 1–3(–4) mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous, sparsely pubescent basally; abaxial surface glabrous. **Vernation** rolled. Common in grasslands, on rocky slopes, and along stream banks.

99. MUHLENBERGIA UTILIS (Torr.) Hitchc. — APAREJOGRASS

Plants perennial, solitary or forming small clumps. **Rhizomes** slender, scaly; **stolons** absent. **Culms** 20–40 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** ±0.5 mm long, membranous, truncate; margins entire or slightly erose. **Leaf blades** filiform, 5–20 cm long, 0.5–1 mm wide, involute, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** folded. Occasional along streams and in moist depressions in grasslands.

100. MUHLENBERGIA ×INVOLUTA Swallen — CANYON MUHLY

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 60–140 cm tall, erect, firm, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, the lower sheaths laterally compressed and weakly keeled, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 3–12 mm long, membranous, firm and brown at the base, acute; margins entire or lacerate. **Leaf blades** linear, 10–45 cm long, 2–5 mm wide, conduplicate, firm-textured, apes acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** folded. Occasional in rocky prairie openings and canyons.

101. NASSELLA LEUCOTRICHA (Trin. & Rupr.) R.W. Pohl — TEXAS WINTERGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–70(–90) cm tall, geniculate, firm, glabrous, not swollen at the base. **Culm nodes** antrorsely pubescent. **Leaf sheaths** rounded, glabrous or pubescent externally; margins distinct, open, pilose or pubescent. **Collar** continuous, pilose; margins pilose. **Auricles** absent. **Ligules** absent or, if present, to 1 mm long, membranous, truncate; margins entire. **Leaf blades** linear, 10–30(–40) cm long, 2–5 mm wide, plane or involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces strigose. **Vernation** rolled. Abundant in grasslands and along roadsides and other disturbed sites. Treated as *Stipa leucotricha* Trin. & Rupr. by Correll and Johnston (1970) and Gould (1975).

102. PANICUM ANTIDOTALE Retz. — BLUE PANICUM

Plants perennial, solitary or forming small clumps. **Rhizomes** thick, knotted, scaly; **stolons** absent. **Culms** 50–200(–300) cm tall, erect or geniculate, firm, glabrous, glaucous, arising from a hard, knotty base. **Culm nodes** antrorsely pubescent, swollen. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins puberulent. **Auricles** absent. **Ligules** 0.5–1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 6–30 cm long, 4–12 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous, puberulent basally; abaxial surface glabrous; midnerve conspicuous. **Vernation** rolled. Occasional along roadsides and on disturbed sites.

103. PANICUM CAPILLARE L. — COMMON WITCHGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–80 cm tall, erect or geniculate, firm, glabrous, often antrorsely pubescent toward the nodes, not swollen at the base. **Culm nodes** antrorsely pubescent. **Leaf sheaths** rounded, hispid externally with papillose hairs; margins distinct, open, hispid, often with papillose hairs. **Collar** continuous, broad, pubescent; margins pubescent. **Auricles** absent. **Ligules** 0.5–1 mm long, membranous, truncate; margins ciliate with hairs 0.5–1 mm long. **Leaf blades** linear or lanceolate, 10–25 cm long, 5–15(–25) mm wide, plane, firm-textured; apex acute; margins entire, occasionally pilose with papillose hairs or ciliate; adaxial surface hispid or hirsute, often with papillose hairs present on the lower half of the blade; abaxial surface hispid or hirsute or glabrous; midnerve conspicuous. **Vernation** rolled. Common along roadsides and on other disturbed sites.

104. PANICUM COLORATUM L. — KLEINGRASS

Plants perennial, cespitose. **Rhizomes** short, knotty; **stolons** absent. **Culms** 60–135 cm tall, erect or decumbent, firm, glabrous, not swollen at the base, arising from a hard, knotty base. **Culm nodes** glabrous or puberulent. **Leaf sheaths** rounded, glabrous or hispid externally with papillose hairs; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–2 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 3–30 cm long, 2–6(–8) mm wide, plane, firm-textured; apex acute or acuminate; margins entire; adaxial and abaxial surfaces glabrous or hirsute. **Vernation** rolled. Occasional along roadsides and in pastures.

105. PANICUM HALLII Vasey — HALL'S PANICUM

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–80 cm tall, erect or geniculate, firm, glabrous, glaucous, not swollen at the base. **Culm nodes** antrorsely pubescent or glabrous. **Leaf sheaths** rounded, glabrous externally or sparsely pilose with papillose hairs; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire, occasionally sparsely villous.

Auricles absent. **Ligules** <0.5 mm long, membranous, truncate; margins ciliate with hairs 1–1.5 mm long. **Leaf blades** linear, 4–30 cm long, 2–10 mm wide, plane, firm-textured, glaucous; apex acute; margins entire, occasionally with very few papillose hairs basally; adaxial surface glabrous or sparsely pilose; abaxial surface glabrous. **Vernation** rolled. Common and widespread in grasslands, woodlands, rangeland, and pastures.

106. PANICUM VIRGATUM L. — SWITCHGRASS

Plants perennial, cespitose. **Rhizomes** scaly; **stolons** absent. **Culms** 60–200(–300) cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous or pubescent. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire, often ciliate near the throat. **Collar** continuous, broad, glabrous; margins ciliate, often entire. **Auricles** absent. **Ligules** ±1 mm long, a fringe of hairs, interspersed with long, soft hairs 3–5 mm long. **Leaf blades** linear, 10–60 cm long, 3–15 mm wide, plane, firm-textured; apex acute; margins scabrous; adaxial surface glabrous, often pilose basally; abaxial surface glabrous. **Vernation** rolled. Common on seepage slopes, along river margins, and in swales and ditches.

107. PAPPOPHORUM BICOLOR E. Fourn. — PINK PAPPUSGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–80(–100) cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths**, rounded, glabrous externally; margins distinct, overlapping, entire. **Collar** continuous, hirsute; margins pubescent. **Auricles** absent. **Ligules** ±1 mm long, a fringe of hairs. **Leaf blades** linear, 10–20(–30) cm long, 1.5–5 mm wide, plane or involute, firm-textured; apex acute; margins entire; adaxial surface scabrous with a fringe of long, soft hairs immediately above the ligule; abaxial surface glabrous. **Vernation** rolled. Common in grasslands and along roadsides in the southern and western portions of the Hill Country.

108. PAPPOPHORUM VAGINATUM Buckley — WHIPLASH PAPPUSGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–90 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, overlapping, entire. **Collar** continuous, glabrous; margins entire, glabrous or ciliate. **Auricles** absent. **Ligules** ±1 mm long, a fringe of hairs. **Leaf blades** linear, 10–20(–30) cm long, 2–5 mm wide, plane or involute, firm-textured; apex acuminate; margins entire; adaxial surface scabrous with a fringe of long, soft hairs immediately above the ligule; abaxial surface glabrous. **Vernation** rolled. Occasional in grasslands and along roadsides in the southern and western portions of the Hill Country.

109. PASPALUM DILATATUM Poir. — DALLISGRASS

Plants perennial, cespitose. **Rhizomes** short, knotty; **stolons** absent. **Culms** 15–20 cm tall, erect, firm, glabrous, arising from a hard, knotty base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, glabrous externally, the lowermost sheaths hirsute externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–4 mm long, membranous, obtuse; margins entire. **Leaf blades** linear, 6–45 cm long, 3–12 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous with a few long, soft hairs basally; abaxial surface glabrous. **Vernation** rolled. Common and widespread weed of lawns, roadsides, and disturbed areas.

110. PASPALUM DISTICHUM L. — KNOTGRASS

Plants perennial, mat-forming. **Rhizomes** present; **stolons** absent. **Culms** 8–60 cm tall, decumbent, firm, glabrous, not swollen at the base. **Culm nodes** pubescent. **Leaf sheaths** rounded, weakly keeled, glabrous or pilose externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire with a few soft hairs. **Auricles** absent. **Ligules** 1–2.5 mm long, membranous, obtuse or truncate; margins entire to slightly erose. **Leaf blades** linear, 3–12 cm long, 2–6 mm wide, plane, occasionally folded or convolute, firm-textured; apex acute; margins scabrous; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common along ponds and river margins in moist or wet soil.

111. PASPALUM PUBIFLORUM Rupr. ex E. Fourn. — HAIRYSEED PASPALUM

Plants perennial, solitary or forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 40–80 cm tall, decumbent, firm, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous, often tomentose. **Leaf sheaths** rounded, glabrous externally, the lower sheaths pilose externally with papillose hairs; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–3 mm long, membranous, often brownish, truncate; margins entire. **Leaf blades** lanceolate, 6–30 cm long, 6–15 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous, sparsely hirsute basally; abaxial surface glabrous. **Vernation** rolled. Widespread in roadside ditches and other low-lying sites.

112. PASPALUM SETACEUM Michx. — THIN PASPALUM

Plants perennial, cespitose. **Rhizomes** short; **stolons** absent. **Culms** 30–80 cm tall, erect, firm, glabrous, arising from a hard, knotty base. **Culm nodes** glabrous, **Leaf sheaths** rounded, sparsely pilose or pubescent externally; margins distinct, open, entire or pilose. **Collar** continuous, pubescent; margins entire or pilose. **Auricles** absent. **Ligules** to 0.5 mm long, membranous, truncate; margins entire. **Leaf blades** linear, 5–35 cm long, 2–20 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous with a fringe of long, soft hairs immediately above the ligule, occasionally pubescent; abaxial surface glabrous, occasionally pubescent. **Vernation** folded. Widespread on disturbed sites, especially on sandy soil.

113. PASPALUM URVILLEI Steud. — VASEYGRASS

Plants perennial, cespitose. **Rhizomes** short, knotty; **stolons** absent. **Culms** 100–200 cm tall, erect, firm, arising from a hard, knotty base. **Culm nodes** glabrous. **Leaf sheaths** rounded, the lower sheaths hirsute externally, the upper sheaths glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 3–6 mm long, membranous, obtuse; margins lacerate. **Leaf blades** linear, 10–40 cm long, 4–15 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface glabrous with a fringe of long, soft hairs immediately above the ligule; abaxial surface glabrous. **Vernation** rolled. Widespread along shorelines, roadside ditches, and other low-lying sites.

114. PENNISETUM CILIARE (L.) Link — BUFFELGRASS

Plants perennial, cespitose. **Rhizomes** present or absent; **stolons** absent. **Culms** 25–100 cm tall, geniculate, wiry, glabrous, arising from a hard, knotty base. **Culm nodes** glabrous, occasionally puberulent. **Leaf sheaths** laterally compressed, keeled, glabrous or sparsely pilose externally;

margins distinct, open, entire. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 0.5–2 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 8–30 cm long, 2.5–8 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface sparsely pilose or pubescent basally, otherwise glabrous; abaxial surface glabrous. **Vernation** rolled. Uncommon on disturbed sites in a few southern and western Hill Country counties. Treated as *Cenchrus ciliaris* L. by Correll and Johnston (1970) and Gould (1975).

115. PHALARIS CAROLINIANA Walt. — CAROLINA CANARYGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–70 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, narrow, glabrous; margins entire. **Auricles** absent. **Ligules** 2–6 mm long, membranous, obtuse; margins erose often appearing dentate. **Leaf blades** linear, 5–20 cm long, 3–7 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common and widespread on wet or marshy sites.

116. PHRAGMITES AUSTRALIS (Cav.) Trin. ex Steud. — COMMON REED

Plants perennial, solitary or forming large clumps. **Rhizomes** thick; **stolons** absent or present. **Culms** 2–4 m tall, erect, tough, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous margins entire. **Auricles** absent. **Ligules** to 0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 20–60 cm long, 15–50 mm wide, plane, firm-textured; apex attenuate, often involute; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Uncommon along streams; reported from only a few Hill Country counties.

117. POA ANNUA L. — ANNUAL BLUEGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 6–30 cm tall, erect or geniculate, the outermost culms of a clump decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, the lowermost sheaths membranous; margins distinct, open, entire, upper margins thin, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1.5–4 mm long, membranous, decurrent on both sides, obtuse; margins entire or erose. **Leaf blades** linear, 2–14 cm long, 1.5–4 mm wide, plane, firm-textured; apex obtuse , prow-shaped; margins entire; adaxial surface glabrous, median lines present; abaxial surface glabrous. **Vernation** folded. A common weed of lawns and gardens.

118. POA ARACHNIFERA Torr. — TEXAS BLUEGRASS

Plants perennial, cespitose. **Rhizomes** slender, elongate; **stolons** absent. **Culms** 35–50 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–4 mm long, membranous, acute; margins entire. **Leaf blades** linear, 7.5–15 long, 1–5 mm wide, plane, less frequently conduplicate, firm-textured; apex acute; margins entire; adaxial surface glabrous; abaxial surface glabrous, scabrous on the midnerve. **Vernation** folded. Widespread in grasslands and along the margins of woodlands.

119. POLYPOGON MONSPELIENSIS (L.) Desf. — RABBITFOOT GRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 8–70 cm tall, erect or geniculate, the outermost culms of a clump decumbent, weak, glabrous, not swollen at the base, often

rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or scabrous externally; margins distinct, open, entire, upper margins thin, hyaline. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 3–15 mm long, membranous, decurrent on both sides, acute; margins lacerate. **Leaf blades** linear, 4–16 cm long, 2–8 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces scabrous. **Vernation** rolled. Common and widespread along streams and other moist or wet, disturbed sites.

120. POLYPOGON VIRIDIS (A. Gouan) Breistr. — WATER BENTGRASS

Plants perennial, cespitose. **Rhizomes** absent; **stolons** present. Culms 10–50(–70) cm tall, geniculate or decumbent, succulent, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or scabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 2–7 mm long, membranous, obtuse; margins lacerate. **Leaf blades** linear, 4–14 cm long, 2–8 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** rolled. Occasional along streams and in roadside ditches. Treated as *Agrostis semiverticillata* (Forssk.) Christ by Correll and Johnston (1970) and Gould (1975).

121. SCHEDONNARDUS PANICULATUS (Nutt.) Trel. — TUMBLEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 8–50(–70) cm tall, decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally; margins distinct, open, entire, upper margins thin, hyaline. **Collar** continuous or divided, glabrous; margins entire. **Auricles** absent. **Ligules** 1–3.5 mm long, membranous, decurrent on either side as sheath margins, acute; margins entire. **Leaf blades** linear, 2–12 cm long, 0.5–2(–3) mm wide, plane or conduplicate and becoming spirally twisted upon drying, firm-textured; apex acute; margins scabrous, slightly undulate, whitish; adaxial and abaxial surfaces glabrous; midnerve strongly conspicuous abaxially. **Vernation** folded. Common and widespread on disturbed sites.

122. SCHIZACHYRIUM SCOPARIUM (Michx.) Nash — LITTLE BLUESTEM

Plants perennial, cespitose. **Rhizomes** absent or short when present; **stolons** absent. **Culms** 50–200 cm tall, erect, firm, glabrous, often glaucous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous or pubescent or pilose or hirsute externally; margins distinct, open, entire, occasionally pilose near the throat. **Collar** continuous, broad, glabrous; margins entire. **Auricles** absent. **Ligules** 1–3 mm long, membranous, firm-textured, obtuse; margins erose, often appearing dentate. **Leaf blades** linear, 15–30 cm long, 1.5–4(–6) mm wide, plane, firm-textured; apex acute; margins scabrous; adaxial surface glabrous or scabrous, occasionally hispid; abaxial surface glabrous. **Vernation** folded. Widespread and common in grasslands, open woodlands, and along roadsides.

123. SETARIA GRISEBACHII E. Fourn. — GRISEBACH'S BRISTLEGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 40–80(–100) cm tall, erect or geniculate, slender, glabrous, not swollen at the base, **Culm nodes** hirsute. **Leaf sheaths** rounded, pilose externally; margins distinct, open, pilose. **Collar** continuous, pilose; margins ciliate. **Auricles** absent. **Ligules** ±1mm long, a fringe of hairs. **Leaf blades** linear, 6–20 cm long, 5–13 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces hispid. **Vernation** rolled. Uncommon on open, rocky slopes.

124. SETARIA LEUCOPILA (Scribn. & Merr.) K. Schum. — PLAINS BRISTLEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–100 cm tall, erect or geniculate, firm, glabrous, occasionally distally pubescent, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally with a fringe of long hairs just below the collar; margins distinct, open, entire, villous near the throat. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** ±0.5 mm long, membranous, truncate; margins ciliate with hairs 1–2 mm long. **Leaf blades** linear, 8–25 cm long, 2–5 mm wide, plane or conduplicate, firm-textured, pale green or glaucous; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** rolled. Widespread and common on sites with abundant moisture.

125. SETARIA PARVIFLORA (Poir.) Kerguélen — KNOTROOT BRISTLEGRASS

Plants perennial, cespitose. **Rhizomes** short, knotty; **stolons** absent. **Culms** 30–100 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, the lowermost sheaths keeled just below the collar, glabrous or scabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** ±1 mm long, a fringe of hairs. **Leaf blades** linear, 6–25 cm long, 2–8 mm wide, plane, firm-textured; apex acuminate; margins entire or scaberulous; adaxial surface glabrous or scaberulous, occasionally with a few long, coarse hairs basally; abaxial surface glabrous or scabrous. **Vernation** rolled. Common and widespread along shorelines, streams, roadside ditches and other moist sites.

126. SETARIA PUMILA (Poir.) Roem. & Schult. — YELLOW FOXTAIL; PIGEONGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–120 cm tall, geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally; margins distinct, open, entire, ciliate near the throat. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** ±1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 3–30 cm long, 4–10 mm wide, loosely twisted, firm-textured; apex acute; margins entire; adaxial surface scabrous with long, soft hairs basally; abaxial surface glabrous. **Vernation** rolled. An occasional weed of fields, roadsides, and other disturbed sites.

127. SETARIA REVERCHONII (Vasey) Pilger — REVERCHON BRISTLEGRASS

Plants perennial, cespitose. **Rhizomes** short, scaly, pubescent; **stolons** absent. **Culms** 35–70 cm tall, erect, firm, arising from a hard, knotty base. **Culm nodes** glabrous. **Leaf sheaths** rounded, the lower sheaths sparsely hirsute externally, the upper sheaths glabrous externally; margins distinct, open, entire. **Collar** continuous, the lower collars pubescent, the upper glabrous; margins entire. **Auricles** absent. **Ligules** ±0.5 mm long, membranous, truncate; margins ciliate with hairs 1–2 mm long, often with longer hairs at the edges. **Leaf blades** linear, 4–10(–20) cm long, 2–3 mm wide, plane, involute upon drying, firm-textured; apex acute; margins entire with a few long, soft hairs basally; adaxial surface scabrous; abaxial surface glabrous. **Vernation** rolled. Widespread and common in grasslands, on rocky slopes, and in gravelly soils.

128. SETARIA SCHEELEI (Steud.) Hitchc. — SOUTHWESTERN BRISTLEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 70–130 cm tall, geniculate, firm, glabrous, not swollen at the base. **Culm nodes** antrorsely puberulent. **Leaf sheaths** rounded, glabrous externally, distally pilose; margins distinct, open, entire, pilose near the throat. **Collar** continuous, pubescent; margins entire, glabrous or ciliate. **Auricles** absent. **Ligules** ± 0.5

mm long, membranous, truncate; margins ciliate with hairs 1–2 mm long. **Leaf blades** linear, 15–30(–50) cm long, 5–18 mm wide, plane or conduplicate, firm-textured; apex acute; margins entire; adaxial surface scabrous and finely pubescent, pilose basally; abaxial surface scabrous and finely pubescent. **Vernation** folded. Common in the shade of woodlands, canyons, and river bottoms.

129. SETARIA VERTICILLATA (L.) P. Beauv. — HOOKED BRISTLEGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–70 cm tall, decumbent, weak, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** laterally compressed, keeled, glabrous externally; margins distinct, open, inner margins entire, outer margins distally ciliate. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, a fringe of hairs. **Leaf blades** linear, 5–30 cm long, 4–16 mm wide, plane; apex acute; margins entire; adaxial and abaxial surfaces glabrous or sparsely hispid. **Vernation** rolled. Occasional in disturbed habitats.

130. SETARIA VILLOSISSIMA (Scribn. & Merr.) K. Schum. — HAIRYLEAF BRISTLEGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous or sparsely pubescent. **Leaf sheaths** rounded, glabrous or hirsute externally; margins distinct, open, entire, hirsute near the throat. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 1–2 mm long, a fringe of hairs. **Leaf blades** linear, 10–25 cm long, 6–14 mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces pilose or sparsely pilose; midnerve conspicuous abaxially. **Vernation** rolled. Uncommon and apparently restricted to soils derived from granite.

131. SETARIA VIRIDIS (L.) P. Beauv. — GREEN BRISTLEGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 25–100 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous, the lowermost nodes often hirsute. **Leaf sheaths** slightly laterally compressed laterally, keeled, glabrous externally; margins distinct, open, inner margins entire, outer margins ciliate or pilose. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, a fringe of hairs. **Leaf blades** linear, 8–20 cm long, 3–10 mm wide, plane, firm-textured; apex acute; margins entire, undulate; adaxial surface scabrous; abaxial surface glabrous. **Vernation** rolled. A widespread but scattered weed of roadsides, fields, and disturbed sites.

132. SORGHASTRUM NUTANS (L.) Nash — INDIANGRASS

Plants perennial, solitary or forming small clumps. **Rhizomes** short, stout, scaly; **stolons** absent. **Culms** 80–230 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** hispid. **Leaf sheaths** rounded, glabrous or sparsely pilose externally; margins distinct, open, entire, upper margins membranous, continuous with the auricles and ligules. **Collar** continuous, glabrous; margins entire with a few long, soft hairs. **Auricles** present, ±2 mm longer than the ligules, stiff, erect. **Ligules** 2–6 mm long, membranous, indurate when dry, truncate; margins erose, ciliolate. **Leaf blades** linear, 10–50 cm long, 5–10 mm wide, plane, firm-textured, tapered to a narrow base; apex attenuate; margins scabrous; adaxial surface scabrous; abaxial surface glabrous; midnerve conspicuous. **Vernation** rolled. Widespread in open woodlands and along roadsides.

133. SORGHUM BICOLOR (L.) Moench — SORGHUM

Plants annual, solitary. **Rhizomes** and **stolons** absent. **Culms** 80–250(–500) cm tall, erect, stout, succulent, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–3 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 30–100 cm long, 10–50 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous; midnerve conspicuous, whitish. **Vernation** folded. Cultivated and occasionally found as a waif along roadsides.

134. SORGHUM HALEPENSE (L.) Pers. — JOHNSONGRASS

Plants perennial, cespitose. **Rhizomes** elongate, scaly; **stolons** absent. **Culms** 100–200 cm tall, erect or geniculate, the outermost culms of a clump decumbent, firm, glabrous, not swollen at the base. **Culm nodes** pubescent, less frequently glabrous. **Leaf sheaths** rounded, glabrous externally, occasionally purplish; margins distinct, open, entire. **Collar** continuous, glabrous or pubescent; margins entire, glabrous or ciliate. **Auricles** absent. **Ligules** 1.5–4 mm long, membranous, truncate; margins ciliate. **Leaf blades** linear, 20–90 cm long, 8–20 mm wide, plane, firm-textured; apex acuminate; margins entire, hyaline or white-colored; adaxial surface glabrous, pubescent at the base just behind the ligule; abaxial surface glabrous; midnerve conspicuous, often whitish. **Vernation** rolled. Widespread and abundant along roadsides, field margins, vacant lots, and dother isturbed sites.

135. SPHENOPHOLIS OBTUSATA (Michx.) Scribn. — PRAIRIE WEDGESCALE

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–70(–120) cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or scabrous externally; margins distinct, open, entire. **Collar** divided, often oblique, glabrous; margins entire. **Auricles** absent. **Ligules** 1.5–3 mm long, membranous, obtuse or truncate; margins lacerate. **Leaf blades** linear 4–15 cm long, 2–8 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** rolled. Widespread in moist woodlands, grasslands, and disturbed sites.

136. SPOROBOLUS AIROIDES (Torr.) Torr. — ALKALI SACATON

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–150 cm tall, erect, firm, glabrous, arising from a hard, subrhizomatous base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins sparsely pilose. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, 15–45 cm long, 2–6 mm wide, plane or involute, firm-textured; apex acute; margins entire; adaxial surface scabrous, occasionally glabrous; abaxial surface glabrous. **Vernation** folded. A common species of saline falts in south and west Texas; known from a few scattered Hill Country localities on dry, rocky slopes.

137. SPOROBOLUS CLANDESTINUS (Biehler) Hitchc. — HIDDEN DROPSEED

Plants perennial, solitary or forming small clusters. **Rhizomes** and **stolons** absent. **Culms** 60–150 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, overlapping, glabrous externally, the lower sheaths pilose near the throat; margins distinct, overlapping, entire. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 10–30 cm long, 1–4 mm wide,

plane or involute, firm-textured; apex acute; margins entire; adaxial surface glabrous, pilose basally; abaxial surface glabrous. **Vernation** rolled. Occasional in sandy soils along roadsides. Treated as a synonym of *S. asper* (Michx.) Kunth by Correll and Johnston (1970).

We have found no vegetative characters that can be used to reliably distinguish between this taxon and *S. compositus*.

138. SPOROBOLUS COMPOSITUS (Poir.) Merr. — ROUGH DROPSEED

Plants perennial, solitary or forming small clumps. **Rhizomes** elongate, scaly, or absent; **stolons** absent. **Culms** 60–150 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, overlapping, glabrous externally, the lower sheaths pilose near the throat; margins distinct, overlapping, entire. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** <0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 10–30 cm long, 1–4 mm wide, plane or involute, firm-textured; apex acute; margins entire; adaxial surface glabrous, pilose basally; abaxial surface glabrous. **Vernation** rolled. Common in grasslands, woodlands, and along roadsides. Treated as *S. asper* (Michx.) Kunth by Correll and Johnston (1970) and Gould (1975).

We have found no vegetative characters that can be used to reliably distinguish between this taxon and *S. clandestinus*.

139. SPOROBOLUS CRYPTANDRUS (Torr.) A. Gray — SAND DROPSEED

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 35–120 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, overlapping, inner margins entire, outer margins ciliate. **Collar** continuous, glabrous; margins pilose. **Auricles** absent. **Ligules** 0.5–1 mm long, a fringe of hairs. **Leaf blades** linear, 8–25 cm long, 2–5 mm wide, plane or conduplicate, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** rolled. Common and widespread along roadsides, in pastures, and on other disturbed sites, especially on sandy soils.

140. SPOROBOLUS PYRAMIDATUS (Lam.) Hitchc — WHORLED DROPSEED

Plants annual or perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–50 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, shorter than the adjacent internodes, glabrous externally; margins distinct, open, inner margins entire, outer margins ciliate distally. **Collar** continuous, glabrous; margins sparsely pilose. **Auricles** absent. **Ligules** <1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 3–12(–20) cm long, 2–4 mm wide; apex acute often involute; margins strigose; adaxial surface basally hispid otherwise glabrous; abaxial surface glabrous. **Vernation** rolled. Common along roadsides and on other open, disturbed sites.

141. SPOROBOLUS VAGINIFLORUS (Torr. ex A. Gray) Alph. Wood — POVERTY DROPSEED

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 15–60 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, shorter than the adjacent internodes, glabrous or sparsely pilose externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire with 1 or 2 long, soft hairs. **Auricles** absent. **Ligules** <0.5 mm long, a fringe of hairs. **Leaf blades** linear, basal blades 4–13 cm long, 1–2 mm wide, upper blades 1–

5 cm long, 1–2 mm wide, plane or involute, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous, occasionally hispid or pilose. **Vernation** rolled. Widespread and often abundant on disturbed areas over limestone.

142. STEINCHISMA HIANS (Ell.) Nash — GAPING PANICGRASS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. Culms 20–75 cm tall, erect or decumbent, firm, glaucous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** slightly laterally compressed, glabrous externally; margins distinct, open, entire, ciliate near the throat. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 6–18 cm long, 2–5 mm wide, plane or conduplicate, firm-textured; apex acute; margins entire; adaxial surface glabrous, pilose basally; abaxial surface glabrous. **Vernation** rolled. Primarily an east Texas species that occasionally occurs in moist depressions in grasslands and woodlands in a few Hill Country counties. Treated as *Panicum hians* Elliott by Correll and Johnston (1970) and Gould (1975).

143. STENOTAPHRUM SECUNDATUM (Walt.) Kuntze — ST. AUGUSTINEGRASS

Plants perennial, mat-forming. **Rhizomes** absent; **stolons** present. **Culms** 10–30 cm tall, prostrate or decumbent, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaves** distichous. **Leaf sheaths** compressed, occasionally weakly keeled, glabrous externally; margins distinct, open, entire, ciliate near the throat. **Collar** continuous, glabrous; margins ciliate. **Auricles** absent. **Ligules** <0.5 mm long, membranous, minute; margins ciliate with stiff hairs. **Leaf blades** linear, 3–15 cm long, 4–10 mm wide, conduplicate, firm-textured; apex obtuse; margins entire; adaxial and abaxial surfaces glabrous. **Vernation** folded. Widely cultivated as a turfgrass.

144. TRAGUS BERTERONIANUS Schult. — SPIKE BURGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 5–40 cm tall, erect or geniculate, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, shorter than the adjacent culm internodes, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins sparsely ciliate. **Auricles** absent. **Ligules** to 1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 1–6 cm long, 2–5 mm wide, plane or loosely folded, firm-textured; apex acute; margins hispid, cartilaginous, whitish; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Occasional on disturbed sites over sandy soil.

145. TRIDENS ALBESCENS (Vasey) Woot. & Standl. — WHITE TRIDENS

Plants perennial, cespitose. **Rhizomes** short, knotty; **stolons** absent. **Culms** 30–90 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** mostly glabrous, the lowermost sparsely pubescent. **Leaf sheaths** mostly rounded, the lowermost weakly keeled, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** <0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 8–25 cm long, 1–4 mm wide, plane, firm-textured, glaucous; apex attenuate, involute; margins barbed; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Common in roadside ditches and other low-lying sites with moist soil.

146. TRIDENS BUCKLEYANUS (L.H. Dewey) Nash — BUCKLEY'S TRIDENS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 40–80 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** antrorsely hispid above, glabrous below. **Leaf sheaths** rounded, scabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous;

margins entire. **Auricles** absent. **Ligules** to 0.5 mm long, membranous; margins truncate, ciliate with hairs to 0.5 mm long. **Leaf blades** linear, 7.5–25 long, 1–4 mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces scabrous, less frequently glabrous. **Vernation** rolled. Occasional in moist woodlands along the eastern margin of the Hill Country.

147. TRIDENS ERAGROSTOIDES (Vasey & Scribn.) Nash — LOVEGRASS TRIDENS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 50–100 cm tall, erect, firm, slender, glabrous, not swollen at the base. **Culm nodes** glabrous or sparsely pilose. **Leaf sheaths** rounded, glabrous or sparsely pilose externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–3 mm long, membranous, obtuse or acute; margins lacerate. **Leaf blades** linear, 10–30 long, 1.5–5 mm wide, plane, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces scabrous, less frequently sparsely pilose. **Vernation** rolled. Occasional in brushy grasslands under shrubs.

148. TRIDENS FLAVUS (L.) Hitchc. — PURPLETOP

Plants perennial, cespitose. **Rhizomes** short, knotty; **stolons** absent. **Culms** 60–180 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, the lowermost sheaths compressed and keeled, glabrous externally; margins distinct, open, entire. **Collar** continuous, pubescent; margins pubescent. **Auricles** absent. **Ligules** <0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 10–50 cm long, 3–10 mm wide, plane, firm-textured; apex attenuate, involute; margins entire; adaxial surface with sparse, matted pubescence behind the ligule, otherwise glabrous or hispid; abaxial surface glabrous or hispid. **Vernation** rolled. Widespread in shaded woodlands.

149. TRIDENS MUTICUS (Torr.) Nash — SLIM TRIDENS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–80 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** pubescent or villous. **Leaf sheaths** rounded, glabrous or scabrous externally, the lowermost sheaths pilose; margins distinct, open, entire. **Collar** continuous, pubescent; margins pubescent or villous. **Auricles** absent. **Ligules** 0.5–1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 6–25 cm long, 1–4 mm wide, involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces glabrous or sparsely pilose. **Vernation** rolled. Common in grasslands, on dry, rocky slopes, and along roadsides.

150. TRIDENS TEXANUS (S. Wats.) Nash — TEXAS TRIDENS

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 20–75 cm tall, erect, firm, slender, pilose, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous or pilose externally; margins distinct, overlapping, entire. **Collar** continuous, pubescent; margins pubescent. **Auricles** absent. **Ligules** ± 1 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 7–20 cm long, 1–5 mm wide, plane or involute, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces hispid. **Vernation** rolled. Widespread but infrequent along roadsides, fencerows, and woodland margins.

151. TRIPLASIS PURPUREA (Walt.) Chapm. — PURPLE SANDGRASS

Plants annual or perennial, cespitose. **Rhizomes** absent in annual individuals and present in perennial indidivduals; **stolons** absent. **Culms** 45–80 cm tall, geniculate, the outermost culms of a clump decumbent, firm, glabrous, not swollen at the base. **Culm nodes** hirsute. **Leaf sheaths**

rounded, glabrous or hispid externally; margins ciliolate. **Collar** continuous, glabrous; margins distinct, open, entire. **Auricles** absent. **Ligules** to 1 mm long, a fringe of hairs. **Leaf blades** linear, 4–8 cm long, 1–3 mm wide, plane or involute, firm-textured; apex attenuate; margins with a few papillose hairs; adaxial and abaxial surfaces glabrous or sparsely pilose with papillose hairs. **Vernation** rolled. Roadsides and other disturbed sites over sandy soils.

152. TRIPOGON SPICATUS (Nees) Ekman — AMERICAN TRIPOGON

Plants perennial, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–30 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous; leaves mostly basal. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins ciliate. **Auricles** absent. **Ligules** <0.5 mm long, membranous, truncate; margins erose, ciliate. **Leaf blades** filiform, 3–10 cm long, ±1 mm wide, plane, becoming involute upon drying, firm-textured; apex attenuate; margins entire; adaxial and abaxial surfaces glabrous or sparsely hirsute. **Vernation** rolled. Common on rocky granitic slopes, occasionally over limestone.

153. TRIPSACUM DACTYLOIDES (L.) L. — EASTERN GAMMAGRASS

Plants perennial, cespitose. **Rhizomes** thick, knotty; **stolons** absent. **Culms** 150–300 cm tall, erect or geniculate, firm, stout, glabrous, not swollen at the base, occasionally producing prop roots. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, shiny; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** to 0.5 mm long, membranous, truncate; margins erose, ciliate. **Leaf blades** linear, 30–75 cm long, 10–25 mm wide, plane, firm-textured; apex attenuate; margins scabrous; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Occasional on moist soil along streams.

154. TRISETUM INTERRUPTUM Buckley — PRAIRIE TRISETUM

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 10–60 cm tall, erect or geniculate, weak, glabrous or distally puberulent, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, hispid externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** 1–2 mm long, membranous, obtuse; margins lacerate, ciliate. **Leaf blades** linear, 2–15 cm long, 1–4 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces sparsely hispid or hispid. **Vernation** rolled. Widespread but rarely abundant in grasslands, woodlands, and riparian habitats..

155. TRITICUM AESTIVUM L. — WHEAT

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 60–100 cm tall, erect, firm, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, the lower sheaths pubescent externally; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** present, to 2.5 mm long. **Ligules** 1–3 mm long, membranous, truncate; margins erose. **Leaf blades** linear, 10–60 cm long, 7–20 mm wide, plane, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous or scabrous. **Vernation** folded. Cultivated and occasionally occurring as a waif along roadsides.

156. UROCHLOA CILIATISSIMA (Buckley) R.D. Webster — FRINGED SIGNALGRASS

Plants perennial, solitary or forming small clumps. **Rhizomes** present or absent; **stolons** present, elongate. **Culms** 15–40 cm tall, erect, firm, glabrous, not swollen at the base, often rooting at the lower nodes. **Culm nodes** glabrous. **Leaf sheaths** rounded, hirsute externally with both long

and short hairs; margins distinct, open, entire. **Collar** continuous, glabrous; margins entire. **Auricles** absent. **Ligules** <0.5 mm long, ciliate with a minute, membranous base. **Leaf blades** linear, 3–8 cm long, 2–7 mm wide, plane, firm-textured; apex acuminate; margins pilose with papillose hairs, cartilaginous, undulate, whitish; adaxial and abaxial surfaces scabrous. **Vernation** rolled. Widespread along roadsides and in pastures over sandy soils.

157. UROCHLOA FUSCA (Sw.) B.F. Hansen & Wunderlin — BROWNTOP SIGNALGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 30–120 cm tall, decumbent, firm, glabrous, the upper internodes puberulent, not swollen at the base, often rooting at the lower nodes. **Culm nodes** antrorsely pubescent. **Leaf sheaths** rounded, glabrous or hispid externally; margins distinct, overlapping, entire, occasionally the outer margins ciliate. **Collar** continuous, oblique, pubescent; margins entire. **Auricles** absent. **Ligules** 0.5–1.5 mm long, ciliate with a minute, membranous base. **Leaf blades** lanceolate, 4–20(–30) cm long, 5–15 mm wide, plane, firm-textured; apex acute; margins entire; adaxial surface hispid with papillose hairs on the lower blades, glabrous on the upper blades; abaxial surface glabrous. **Vernation** rolled. A widespread weedy species in roadside ditches, field margins, and other disturbed sites with moist soil. Treated as *Panicum fasciculatum* Sw. by Correll and Johnston (1970) and Gould (1975), as *Brachiaria fasciculata* (Sw.) S.T. Blake by Hatch et al. (1990), and as *U. fasciculata* (Sw.) R.D. Webster by Turner et al. (2003).

158. UROCHLOA TEXANA (Buckley) R.D. Webster — TEXAS SIGNALGRASS

Plants annual, cespitose. **Rhizomes** and **stolons** absent. **Culms** 40–120 cm tall, decumbent, firm, glabrous or distally puberulent, not swollen at the base, often rooting at the lower nodes. **Culm nodes** pubescent. **Leaf sheaths** rounded, pubescent externally; margins distinct, open, entire. **Collar** continuous, pubescent; margins entire, glabrous or ciliate. **Auricles** absent. **Ligules** ±0.5 mm long, membranous, truncate; margins ciliate with hairs 1–1.5 mm long. **Leaf blades** lanceolate, 8–20 cm long, 7–20 mm wide, plane or conduplicate, firm-textured; apex acute; margins undulate, serrate; adaxial and abaxial surfaces pubescent. **Vernation** rolled. Widespread on sandy, disturbed soils. Treated as *Panicum texamum* Buckley by Correll and Johnston (1970) and Gould (1975) and as *Brachiaria texana* (Buckley) S.T. Blake by Hatch et al. (1990).

159. VULPIA OCTOFLORA (Walt.) Rydb. — COMMON SIXWEEKSGRASS

Plants annual, solitary or forming small clumps. **Rhizomes** and **stolons** absent. **Culms** 10–60 cm tall, geniculate or decumbent, weak, slender, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally, occasionally pubescent externally; margins distinct, open, entire. **Collar** continuous, narrow, glabrous; margins entire. **Auricles** absent. **Ligules** 0.5–1 mm long, slightly longer on the sides, membranous, truncate; margins erose. **Leaf blades** linear, 2–10 cm long, 0.5–1 mm wide, involute, firm-textured; apex acute; margins entire; adaxial and abaxial surfaces glabrous or pubescent. **Vernation** folded. Widespread on disturbed sites.

160. ZIZANIOPSIS MILIACEA (Michx) Döll & Asch. — SOUTHERN WILDRICE

Plants perennial, forming large clumps. **Rhizomes** elongate; **stolons** absent. Culms 2–3 m tall, erect, firm, thick, glabrous, not swollen at the base. **Culm nodes** glabrous. **Leaf sheaths** rounded, glabrous externally; margins distinct, open, entire. **Collar** continuous, wide, glabrous; margins entire. **Auricles** absent. **Ligules** 6–20 mm long, membranous, with numerous fine nerves, acute; margins erose. **Leaf blades** linear, 50–100(–150) cm long, 8–25 mm wide, plane, firm-textured; apex acute; margins serrate; adaxial and abaxial surfaces glabrous. **Vernation** rolled. Occasional in shallow water along streams.

ACKNOWLEDGEMENTS

Appreciation is extended to Dr. Stephan Hatch for contributing his invaluable expertise to the preparation of this work and to the curators of SWT, TAES and TEX-LL for allowing access to, and use of, their collections. Much of this work was included in a thesis submitted to the Graduate College at Texas State University by the senior author in partial fulfillment of the requirements for the Master of Science degree.

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Appendix A. Genera and species of Texas Hill Country grasses included in this treatment. The arrangement of subfamilies and tribes follows Shaw (2012).

Family Poaceae

Subfamily Aristidoideae
Tribe Aristideae
Aristida adscensionis L.
Aristida longespica Poir.
Aristida oligantha Michx.
Aristida purpurea Nutt.

Subfamily Arundinoideae
Tribe Arundineae
Arundo donax L.
Phragmites australis (Cav.) Trin. ex Steud.

Subfamily Centothecoideae
Tribe Centotheceae
Chasmanthium latifolium (Michx.) H.O. Yates

Subfamily Chloridoideae
Tribe Cynodonteae
Bouteloua aristidoides (Kunth) Griseb.
Bouteloua barbata Lag.
Bouteloua curtipendula (Michx.) Torr.
Bouteloua hirsuta Lag.
Bouteloua repens (Kunth) Scribn. & Merr.
Bouteloua rigidiseta (Steud.) Hitchc.
Bouteloua trifida Thurb.
Bouteloua uniflora Vasey
Buchloë dactyloides (Nutt.) Engelm.
Chloris andropogonoides E. Fourn.
Chloris cucullata Bisch.
Chloris verticillata Nutt.
Chloris virgata Sw.
Cynodon dactylon (L.) Pers.
Dactyloctenium aegyptium (L.) Willd.
Eleusine indica (L.) Gaertn.
Eragrostis barrelieri Daveau
Eragrostis cilianensis (All.) Vignolo ex Janch.
Eragrostis curtipedicellata Buckley
Eragrostis curvula (Schrad.) Nees
Eragrostis intermedia Hitchc.
Eragrostis lugens Nees
Eragrostis pectinacea (Michx.) Nees ex Steud.

Eragrostis reptans (Michx.) Nees
Eragrostis secundiflora J. Presl
Eragrostis spectabilis (Pursh) Steud.
Eragrostis superba Peyr.
Eragrostis trichodes (Nutt.) A. Wood
Erioneuron pilosum (Buckley) Nash
Hilaria belangeri (Steud.) Nash
Hilaria mutica (Buckley) Benth.
Leptochloa dubia (Kunth) Nees
Leptochloa fusca (L.) Kunth
Leptochloa panicea (Retz.) Ohwi
Muhlenbergia arenacea (Buckley) Hitchc.
Muhlenbergia lindheimeri Hitchc.
Muhlenbergia porteri Scribn. ex Beal
Muhlenbergia reverchonii Vasey & Scribn.
Muhlenbergia schreberi Gmel.
Muhlenbergia utilis (Torr.) Hitchc.
Muhlenbergia xinvoluta Swallen
Schedonnardus paniculatus (Nutt.) Trel.
Sporobolus airoides (Torr.) Torr.
Sporobolus clandestinus (Biehler) Hitchc.
Sporobolus compositus (Poir.) Merr.
Sporobolus cryptandrus (Torr.) A. Gray
Sporobolus pyramidatus (Lam.) Hitchc.
Sporobolus vaginiflorus (Torr. ex A. Gray) A. Wood
Tragus berteronianus Schult.
Tridens albescens (Vasey) Wooton & Standl.
Tridens buckleyanus (L.H. Dewey) Nash
Tridens eragrostoides (Vasey & Scribn.) Nash
Tridens flavus (L.) Hitchc.
Tridens muticus (Torr.) Nash
Tridens texanus (S. Wats.) Nash
Triplasis purpurea (Walt.) Chapm.
Tripogon spicatus (Nees) Ekman

Tribe Pappophoreae

Pappophorum bicolor E. Fourn.
Pappophorum vaginatum Buckley

Subfamily Ehrhartoideae

Tribe Oryzeae

Leersia oryzoides (L.) Sw.
Zizaniopsis miliacea (Michx) Döll & Aschers.

Subfamily Panicoideae

Tribe Andropogoneae

Andropogon gerardii Vitman
Andropogon glomeratus (Walt) B.S.P.
Andropogon virginicus L.
Bothriochloa barbinodis (Lag.) Herter
Bothriochloa edwardsiana (Gould) Parodi
Bothriochloa hybrida (Gould) Gould

Bothriochloa ischaemum (L.) Keng
Bothriochloa laguroides (DC.) Herter
Coelorachis cylindrica (Michx.) Nash
Dichanthium annulatum (Forssk.) Stapf
Heteropogon contortus (L.) P. Beauv.
Schizachyrium scoparium (Michx.) Nash
Sorghastrum nutans (L.) Nash
Sorghum bicolor (L.) Moench
Sorghum halepense (L.) Pers.
Tripsacum dactyloides (L.) L.

Tribe Paniceae

Cenchrus longispinus (Hack.) Fernald
Cenchrus myosuroides Kunth
Cenchrus spinifex Cav.
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark
Dichanthelium oligosanthes (Schult.) Gould
Dichanthelium pedicellatum (Vasey) Gould
Dichanthelium sphaerocarpon (Ell.) Gould
Digitaria californica (Benth.) Henrard
Digitaria ciliaris (Retz.) Koeler
Digitaria cognata (Schult.) Pilg.
Digitaria insularis (L.) Mez ex Ekman
Digitaria patens (Swallen) Henrard
Digitaria sanguinalis (L.) Scop.
Echinochloa colona (L.) Link
Echinochloa crus-galli (L.) P. Beauv.
Echinochloa crus-pavonis (Kunth) Schult.
Eriochloa contracta Hitchc.
Eriochloa sericea (Scheele) Munro ex Vasey
Hopia obtusa (Kunth) Zuloaga & Morrone
Panicum antidotale Retz.
Panicum capillare L.
Panicum coloratum L.
Panicum hallii Vasey
Panicum virgatum L.
Paspalum dilatatum Poir.
Paspalum distichum L.
Paspalum pubiflorum Rupr. ex E. Fourn.
Paspalum setaceum Michx.
Paspalum urvillei Steud.
Pennisetum ciliare (L.) Link
Setaria grisebachii E. Fourn.
Setaria leucopila (Scribn. & Merr.) K. Schum.
Setaria parviflora (Poir.) Kerguélen
Setaria pumila (Poir.) Roem. & Schult.
Setaria reverchonii (Vasey) Pilger
Setaria scheelei (Steud.) Hitchc.
Setaria verticillata (L.) P. Beauv.
Setaria villosissima (Scribn. & Merr.) K. Schum.
Setaria viridis (L.) P. Beauv.
Steinchisma hians (Ell.) Nash

Stenotaphrum secundatum (Walt.) Kuntze
Urochloa ciliatissima (Buckley) R.D. Webster
Urochloa fusca (Sw.) B.F. Hansen & Wunderlin
Urochloa texana (Buckley) R.D. Webster

Subfamily Pooideae

Tribe Bromeae

Bromus catharticus Vahl
Bromus japonicus Thunb.
Bromus pubescens Muhl. ex Willd.
Bromus secalimus L.
Bromus tectorum L.
Bromus texensis (Shear) Hitchc.

Tribe Diarrheneae

Glyceria striata (Lam.) Hitchc.
Melica nitens (Scribn.) Nutt. ex Piper

Tribe Poeae

Agrostis hyemalis (Walt.) B.S.P.
Avena fatua L.
Avena sativa L.
Desmazeria rigida (L.) Tutin
Festuca versuta Beal
Limnodea arkansana (Nutt.) L.H. Dewey
Lolium perenne L.
Lolium temulentum L.
Phalaris caroliniana Walt.
Poa annua L.
Poa arachnifera Torr.
Polypogon monspeliensis (L.) Desf.
Polypogon viridis (A. Gouan) Breistr.
Sphenopholis obtusata (Michx.) Scribn.
Trisetum interruptum Buckley
Vulpia octoflora (Walt.) Rydb.

Tribe Stipeae

Nassella leucotricha (Trin. & Rupr.) R.W. Pohl

Tribe Triticeae

Aegilops cylindrica Host
Elymus canadensis L.
Elymus virginicus L.
Hordeum murinum L.
Hordeum pusillum Nutt.
Hordeum vulgare L.
Triticum aestivum L.

Appendix B. Specimens examined.

Aegilops cylindrica Host
Texas. Blanco Co.: *Wipff et al. 77* (TAES). Eastland Co.: *Gould 7589* (TEX-LL). Hemphill Co.: *Reeder & Reeder 5313* (TEX-LL). Kerr Co.: *Sanchez 1254* (SWT). Llano Co.: *S.&G. Jones 6616* (SWT). Randall Co.: *Hatch 6310* (TAES). Tom Green Co.: *Hatch & Gandhi 5410* (SWT). Travis Co.: *Tharp 53-822* (TEX-LL), *Tharp s.n.* (TEX-LL).

Agrostis hyemalis (Walt.) B.S.P.
Texas. Bowie Co.: *Gould 14278* (TAES). Brazos Co.: *Aljoe 36* (SWT), *Gould 15405* (SWT). Burleson Co.: *Snow 230* (SWT), *Toledo 26* (SWT). Fort Bend Co.: *Knight 138* (SWT). Grimes Co.: *Lemke 224* (SWT). Houston Co.: *S.&G. Jones 1037* (TAES). Jackson Co.: *Cosper 67* (SWT). Leon Co.: *Nixon 17892* (TAES).

Andropogon gerardii Vitman
Texas. Angelina Co.: *Johnston et al. 7131* (SWT). Blanco Co.: *Sanchez 953* (SWT). Coryell Co.: *Sanchez 1428* (SWT). Dallam Co.: *Johnston & Walker 6838* (SWT). Donley Co.: *Johnston & Walker 6797* (SWT). Harris Co.: *Nixon 5995* (SWT). Hartley Co.: *Johnston & Walker 6853* (SWT). Hays Co.: *Lemke 2714* (SWT); *Lyday 290* (SWT). Kendall Co.: *Breckenridge 577* (SWT).

Andropogon glomeratus (Walt.) B.S.P.
Texas. Aransas Co.: *Lemke 734* (SWT). Bandera/Medina Co.: *Lackey 329* (SWT). Blanco Co.: *Ramirez 7* (SWT); *Sanchez 894* (SWT). Comal Co.: *Schoolcraft 48* (SWT). Cameron Co.: *Boylan 426* (SWT). Harris Co.: *Nixon 16075* (SWT). Hays Co.: *Litchfield s.n.* (SWT). Nueces Co.: *Lemke 2066* (SWT). Val Verde Co.: *Labus 64* (SWT).

Andropogon virginicus L.
Texas. Anderson Co.: *Hatch 5072* (SWT). Bastrop Co.: *Carr 9425* (SWT). Galveston Co.: *Hatch 5759* (SWT); *Newcomb 35* (SWT); *Waller 3272* (SWT); *Waller & Bauml 3324* (SWT). Nacogdoches Co.: *Brooks 15* (TAES). San Augustine Co.: *George & Nixon 161* (SWT). Tarrant Co.: *Snowden 915361* (TAES). Tyler Co.: *Johnston et al. 7014* (SWT).

Aristida adscensions L.
Texas. Angelina Co.: *McCall 64-30* (TAES). Brazos Co.: *Redder 53* (TAES); *Morden 128* (TAES). Crockett Co.: *Lemke 2617* (SWT). Dallam Co.: *Johnston & Walker 6827* (SWT). Edwards Co.: *Cory s.n.* (TEX-LL). Hidalgo Co.: *S.&G. Jones 6122* (SWT). Lamb Co.: *Johnston & Walker 6897* (SWT). Oldham Co.: *Johnston & Walker 6864* (SWT). Val Verde Co.: *Tharp 56-21* (TEX-LL).

Aristida longespica Poir.
Texas. Bastrop Co.: *Carr & Kutac 9262, 9265* (TEX-LL). Brazoria Co.: *Hatch 1119* (TAES). Erath Co.: *Hancock 64-9* (TAES). Galveston Co.: *Hatch 1794* (TAES); *Waller & Bauml 3217* (SWT). Houston Co.: *Rosen & Jones 648* (SWT). Lampasas Co.: *Hatch 5819* (TEX-LL). Leon Co.: *Daniel et al. 16* (SWT). Tarrant Co.: *Carr 13159* (TEX-LL).

Aristida oligantha Michx.
Texas. Anderson Co.: *Hatch 5081* (SWT). Caldwell Co.: *Breckenridge 548* (SWT). Comal Co.: *Neely 18* (SWT); *Stapper 49* (SWT). Galveston Co.: *Waller & Bauml 3189* (SWT). Hays Co.: *Ruiseco 21* (SWT). Oldham Co.: *Johnston & Walker 6874* (SWT). San Augustine Co.: *George & Nixon 76* (SWT). Zavala Co.: *Dingee 45* (SWT).

Aristida purpurea Nutt.
Texas. Bee Co.: *Lemke 2256* (SWT). Blanco Co.: *Sanchez 828* (SWT). Guadalupe Co.: *Roberts 169* (SWT). Hays Co.: *Lemke 414, 485, 801* (SWT). Kenedy Co.: *Lemke 311* (SWT). Kerr Co.: *Sanchez 1067* (SWT). Live Oak Co.: *Mittelhauser 176* (SWT). Uvalde Co.: *Lemke 944* (SWT). Val Verde Co.: *Labus 126* (SWT). Zapata Co.: *Lemke 1526* (SWT). Zavala Co.: *Shepard 37* (SWT).

Arundo donax L.
Texas. Bexar Co.: *Bruno 37* (SWT). Blanco Co.: *Hutzler 44* (SWT); *Sanchez 829* (SWT). Calhoun Co.: *Harvey 7580* (TAES). Comal Co.: *Leister 53* (TAES). Fayette Co.: *Mikesky 46* (TAES). Galveston Co.: *Waller 3280* (SWT). Guadalupe Co.: *Jefferies 22* (SWT); *Smith 41* (SWT). Hays Co.: *Litchfield s.n.* (SWT). Titus Co.: *Lemke 1297* (SWT). Travis Co.: *Thomas 70* (SWT).

Avena fatua L.
Texas. Blanco Co.: *Ramirez 193* (SWT). Bexar Co.: *Hagenbuch 27* (SWT). Caldwell Co.: *Lemke 463* (SWT). Comal Co.: *Morris 62* (SWT). Guadalupe Co.: *Shipman 35* (SWT). Travis Co.: *Jones 14* (SWT). Wharton Co.: *Blecha 19* (SWT).

Avena sativa **L.**
Texas. Brazos Co.: *Toledo 17* (TAES). Galveston Co.: *Waller & Campbell 2693* (TAES). Gillespie Co.: *Behrends 54* (SWT). Medina Co.: *Lemke 1747* (SWT).

Bothriochloa barbinodis (Lag.) Herter
Texas. Bexar Co.: *Silveus 7576* (TEX-LL). Brown Co.: *Carr 9665* (TEX-LL). Gaines Co.: *Johnston & Walker 6360* (SWT). Hays Co.: *Gould 6692* (TEX-LL); *Liang 115* (SWT). Kendall Co.: *Carr 9386* (TEX-LL). Kerr Co.: *Brown s.n.* (TEX-LL). Lampasas Co.: *Hatch 5822* (TEX-LL). Real Co.: *Smith & Butterwick 288* (TEX-LL). Travis Co.: *Brown s.n.* (TEX-LL). Val Verde Co.: *Labus 156* (SWT).

Bothriochloa edwardsiana (Gould) Parodi
Texas. Edwards Co.: *Gould & Merrill 5763* (TAES); *Gould & Merrill 5971* (TAES). Kerr Co.: *Brown s.n.* (TEX-LL); *Gould 8241* (TAES). Menard Co.: *Landers 5229* (TAES). Sutton Co.: *Gould & Merrill 5763* (TEX-LL).

Bothriochloa hybrida (Gould) Gould
Texas. Atascosa Co.: *Gould 6223* (TEX-LL). Bastrop Co.: *Oakley 354* (SWT). Burnet Co.: *Lemke 2040* (SWT). Duval Co.: *Hatch 5263* (SWT). Galveston Co.: *Waller & Brauml 2920* (SWT). Guadalupe Co.: *Gould 6940* (TEX-LL). Real Co.: *Gould 6482* (TEX-LL). Travis Co.: *Brown s.n.* (TEX-LL). Uvalde Co.: *Gould 6948, 6950* (TEX-LL). Williamson Co.: *Mears 638* (TEX-LL).

Bothriochloa ischaemum (L.) Keng
Texas. Bandera/Medina Co.: *Lackey 254* (SWT). Blanco Co.: *Lemke 705* (SWT); *Sanchez 772, 938* (SWT). Fort Bend Co.: *Knight 142* (SWT). Hays Co.: Bierner *90-210* (SWT); *Breckenridge 449* (SWT); *Breckenridge 512* (SWT); *Lyday 143* (SWT); *Ruiseco 29* (SWT). Kerr Co.: *Sanchez 1065* (SWT). Lampasas Co.: *Colquitt 16* (SWT); *Robinson 10* (SWT). Val Verde Co.: *Labus 338* (SWT).

Bothriochloa laguroides (DC.) Herter
Texas. Bandera/Medina Co.: *Sanchez 562* (SWT). Burnet Co.: *Breckenridge 613* (SWT). Crockett Co.: *Lemke 2596* (SWT). Gillespie Co.: *Sanchez 969* (SWT). Hays Co.: *Burleson 18* (SWT); *Lyday 247* (SWT); *Monahan 20* (SWT). San Patricio Co.: *Aljoe 32* (SWT). Val Verde Co.: *Labus 298* (SWT).

Bouteloua aristidoides (Kunth) Griseb.
Texas. Burnet Co.: *Carr, Kutac, Lynch & Brown 9143* (TEX-LL); *S.&G. Jones 1903* (TAES); *Powell & Powell 4110* (TAES). Hidalgo Co.: *Carr 14327* (TEX-LL). Llano Co.: *Lemke s.n.* (SWT). Mason Co.: *Emery 815* (TEX-LL). Starr Co.: *Butterwick & Strong 1403* (TEX-LL). Travis Co.: *Carr & Bergquist 11381* (TEX-LL). Webb Co.: *Saenz 1* (TEX-LL). Winkler Co.: *Warnock 18545* (TEX-LL).

Bouteloua barbata Lag.
Texas. Brooks Co.: *Jones 6078* (SWT). Duval Co.: *Ramirez, Alva & McCart 8710* (TEX-LL). El Paso Co.: *Hatch 5854* (SWT). Jeff Davis Co.: *Warnock & Johnston 16880* (SWT). Presidio Co.: *Warnock 14173* (SWT). Scurry Co.: *Johnston 6528* (SWT). Webb Co.: *Baird 60-61-15* (TEX-LL); *McCart, Barreda & Garcia 6* (TEX-LL); *Perez 94* (TEX-LL).

Bouteloua curtipendula (Michx.) Torr.
Texas. Bandera/Medina Co.: *Lackey 279* (SWT). Blanco Co.: *Sanchez 776* (SWT). Brazos Co.: *Kastan 73* (SWT). Brown Co.: *Black 207a* (SWT); *Sumrall 25* (SWT). Burnet Co.: *Oakley 295* (SWT); *Reid 2* (SWT). Comal Co.: *Breckenridge 495* (SWT). Grimes Co.: *Lemke 1933* (SWT). Kimble Co.: *Sanchez 1023* (SWT). Llano Co.: *Lemke* 2054 (SWT). Williamson Co.: *Carr 3225* (SWT).

Bouteloua hirsuta Lag.
Texas. Anderson Co.: *Orzell & Bridges 7977* (SWT). Bandera/Medina Co.: *Lackey 247* (SWT). Burnet Co.: *Lemke 721* (SWT). Comal Co.: *Breckenridge 492* (SWT); *Schoolcraft 60* (SWT). Gillespie Co.: *Boylan 315* (SWT); *Sanchez 988* (SWT). Kendall Co.: *Breckenridge 574* (SWT). Hays Co.: *Breckenridge 517* (SWT); *Jessup 31* (SWT); *Lemke 673* (SWT); *Lyday 135* (SWT). Llano Co.: *Wallace 96* (SWT).

Bouteloua repens (Kunth) Scribn. & Merr.
Texas. Bexar Co.: *Diaz & Higdon H17* (TEX-LL); *Miller s.n.* (TAES). Hidalgo Co.: *Carr, Wolfe & Liu 14312* (TEX-LL); *Gould 9667* (TEX-LL); *Lonard 5009* (SWT). Jim Hogg Co.: *Carr & Whitling 13204* (TEX-LL); *S.&G. Jones 7849* (SWT). La Salle Co.: *Cocke 18* (TAES). Webb Co.: *Gould 11094* (TAES).

Bouteloua rigidiseta (Steud.) Hitchc.
Texas. Bandera/Medina Co.: *Lackey 446* (SWT). Blanco Co.: *Sanchez 907* (SWT). Burleson Co.: *Toledo 25* (SWT). Comal Co.: *Breckenridge 494* (SWT). Gillespie Co.: *Sanchez 959* (SWT). Hays Co.: *Lemke 390, 440, 799, 1566* (SWT); *Liang 101* (SWT); *Lyday 150* (SWT); *Rockett 78* (SWT); *Ruiseco 20* (SWT). Jim Hogg Co.: *Lemke 1566* (SWT). Kerr Co.: *Sanchez 1060* (SWT). Kimble Co.: *Sanchez 1354* (SWT). Kleberg Co.: *Cresson 71* (SWT). McLennan Co.: *Holmes 5035* (SWT). Williamson Co.: *Carr 3216* (SWT). Zavala Co.: *Casey 65* (SWT).

Bouteloua trifida Thurb.
Texas. Blanco Co.: *Launchbaugh 387* (TAES). Comal Co.: *West 35* (TAES). Edwards Co.: *Gibbens 37* (TAES); *Hyman 62* (TAES). Gillespie Co.: *Sanchez 1057* (SWT). Hays Co.: *Breckenridge 609* (SWT); *Jessup 64* (SWT); *Lemke 796* (SWT). Kimble Co.: *Sanchez 1034* (SWT). Llano Co.: *Lemke 695* (SWT). Uvalde Co.: *Shepard 73* (SWT). Val Verde Co.: *Labus 127* (SWT); *Labus 305, 339* (SWT).

Bouteloua uniflora Vasey
Texas. Bandera Co.: *Silveus 7207* (TEX-LL). Brewster Co.: *Warnock 6932* (TEX-LL); *Warnock 23239* (TEX-LL). Edwards Co.: *Brown & Freter s.n.* (TEX-LL). Kerr Co.: *Gould 9751* (TEX-LL);

May 5520 (TEX-LL). Kimble Co.: *Gould 96836* (TEX-LL). Tom Green Co.: *Gould 7802* (TEX-LL). Uvalde Co.: *Silveus 319* (TEX-LL).

Bromus catharticus Vahl
Texas. Bastrop Co.: *Ursin 28* (SWT). Bexar Co.: *Hagenbuch 8* (SWT); *Mayo 51* (SWT). Gillespie Co.: *Weidenfeller 5* (SWT). Lubbock Co.: *Steed & Crumley 64* (SWT). McMullen Co.: *Lemke 1599* (SWT). Medina Co.: *Lemke 1755* (SWT). San Patricio Co.: *Lemke 835* (SWT). Tom Green Co.: *Lemke 1630* (SWT). Uvalde Co.: *Lemke 935* (SWT). Wilson Co.: *Mills 21* (SWT).

Bromus japonicus Thunb.
Texas. Bandera/Medina Co.: *Lackey 547* (SWT). Bastrop Co.: *Jones 89* (SWT). Comal Co.: *Lemke 521* (SWT). Concho Co.: *Hatch & Gandhi 5411* (SWT). Coryell Co.: *Coffey 1628* (SWT). Hays Co.: *Blecha 11* (SWT); *Lackey 91* (SWT); *Ruiseco 37* (SWT). Sabine Co.: *Lemke 1006* (SWT).

Bromus pubescens Muhl. ex Willd.
Texas. Bell Co.: *Carr & Sanchez 17395, 17397* (TEX-LL). Bexar Co.: *Tharp s.n.* (TEX-LL). Blanco Co.: *Tharp 43246* (TEX-LL). Goliad Co.: *Carr 9505* (TEX-LL). Hays Co.: *Carr & Johnson 18089* (TEX-LL). Parker Co.: *Carr 13931* (TEX-LL). Tarrant Co.: *Carr 12821* (TEX-LL). Travis Co.: *Carr 18893, 18904* (TEX-LL); *Lemke 3657* (SWT). Williamson Co.: *Carr 18827* (TEX-LL).

Bromus secalinus L.
Texas. Brazos Co.: *Knight 163* (SWT); *Toledo 18* (SWT). Caldwell Co.: *Lemke 457* (SWT). Comal Co.: *Lemke 399* (SWT). Crockett Co.: *Lemke 2569* (SWT). Grimes Co.: *Lemke 188* (SWT). Guadalupe Co.: *Braswell 94* (SWT). Llano Co.: *Hatch et al. 6243* (SWT). Titus Co.: *Lemke 1791* (SWT).

Bromus tectorum L.
Texas. Blanco Co.: *Sanchez 1213* (SWT); *Wipff et al. 106* (TAES). Kerr Co.: *Hardy 144* (TAES); *McMahan 156* (TAES); *Sanchez 1253, 1279* (SWT). Lipscomb Co.: *Wallis 8436* (TEX-LL). Ochiltree Co.: *Gould 9864* (TEX-LL). Roberts Co.: *Wallis 8520* (TEX-LL).

Bromus texensis (Shear) Hitchc.
Texas. Bexar Co.: *Carr & Diamond 14633* (TEX-LL); *Silveus 7, 615, 5915* (TAES); *Silveus 3911* (TEX-LL);. Refugio Co.: *Hill 6839* (TAES); *Osborn 53* (TAES). San Patricio Co.: Aljoe *15* (SWT); *Anderson 25* (SWT); *Gould 11093* (TEX-LL); *Hatch 4785* (SWT) *Ramu 54* (SWT); *Snow 258* (TEX-LL); *Toledo 38* (SWT).

Buchloë dactyloides (Nutt.) Engelm.
Texas. Bandera/Medina Co.: *Lackey 381* (SWT). Crockett Co.: *Lemke 2626* (SWT). Fayette Co.: *Aljoe 3* (SWT). Gillespie Co.: *Kast 8* (TAES). Jim Hogg Co.: *S.&G. Jones 824* (SWT). Kerr Co.: *Coffey 45* (TAES). Kimble Co.: *Sanchez 1301* (SWT). Scurry Co.: *Johnston 6530* (SWT). Uvalde Co.: *Shepard 65* (SWT). Zavala Co.: *Casey 71* (SWT).

Cenchrus longispinus (Hack.) Fernald
Texas. Brewster Co.: *Warnock & Johnston 16844* (SWT). Carson Co.: *Johnston & Walker 6803* (TEX-LL). Collingsworth Co.: *Gould & Thomas 7731* (TEX-LL). Lamb Co.: *Gould 7739* (TAES). Lubbock Co.: *Gould 7786* (TEX-LL), *Gould 7793* (TAES). Presidio Co.: *Correll & Johnston 24375* (TEX-LL), *Morden 413* (TAES).

Cenchrus myosuroides Kunth
Texas. Bexar Co.: *Tharp s.n.* (SWT). Brazos Co.: *Hatch 1140* (TAES). Hidalgo Co.: *Fleetwood*

10978 (TEX-LL). Presidio Co.: *Butterwick & Strong B-1057* (TEX-LL). San Patricio Co.: *Gould 11956* (TEX-LL), *Gould 13992* (TAES), *Hatch 4456* (TAES). Travis Co.: *DeLisle 973* (TEX-LL). Val Verde Co.: *Eggert s.n.* (TEX-LL), *Warnock & Parks s.n.* (TEX-LL). Webb Co.: *Chamberlain 18* (TEX-LL).

Cenchrus spinifex A. Cavanilles

Texas. Bailey Co.: *Johnston & Walker 6901* (SWT). Bandera/Medina Co.: *Sanchez 629* (SWT). Blanco Co.: *Sanchez 775, 935* (SWT). Brazos Co.: *Redder 11* (SWT); *Windham 27* (SWT). Crockett Co.: *Lemke 2620* (SWT). DeWitt Co.: *Logeman 97* (SWT). Glasscock Co.: *Johnston & Walker 6963* (SWT). Hays Co.: *Breckenridge 456* (SWT). Hidalgo Co.: *Hook 8* (SWT). Kaufman Co.: *Lemke 2920* (SWT). Kinney Co.: *Rosen 242* (SWT). Kleberg Co.: *Lemke 3004* (SWT). Sutton Co.: *Mitchell 55* (SWT). Titus Co.: *Lemke 1244* (SWT).

Chasmanthium latifolium (Michx.) H.O. Yates

Texas. Anderson Co.: *Daniel 41* (SWT). Bexar Co.: *Morris 43* (SWT). Brazos Co.: *McGuyer 3* (SWT); *Perry 9* (SWT). Denton Co.: *Boylan 200* (SWT). Galveston Co.: *Waller & Bauml 2990* (SWT). Guadalupe Co.: *Brainard 5* (SWT). Houston Co.: *S.&G. Jones 3418* (SWT). Kimble Co.: *Sanchez 1051* (SWT). Robertson Co.: *Lemke 3360* (SWT). Travis Co.: *Bierner 90-138* (SWT); *Lemke 1950, 3828* (SWT). Van Zandt Co.: *Johnston 6641* (SWT).

Chloris andropogonoides E. Fourn.

Texas. Atascosa Co.: *Johnston 6197* (TEX-LL). Bexar Co.: *Freeborn 208* (TEX-LL); *Higdon 22* (TEX-LL); *Johnston 2409* (TEX-LL); *Silveus 2332* (TEX-LL). Hays Co.: *Emery 835* (TEX-LL). San Patricio Co.: *Aljoe 30* (SWT); *Gould & Hycka 8027* (TEX-LL). Travis Co.: *Brown E-3, E-6* (TEX-LL).

Chloris cucullata Bisch.

Texas. Atascosa Co.: *Hurley 5* (SWT). Bexar Co.: *Garcia 109* (SWT). Caldwell Co.: *Marr 11* (SWT). Edwards Co.: *Evans 28* (SWT). Frio Co.: *Blecha 37* (SWT). Gillespie Co.: *Boylan 320* (SWT); *Sanchez 966* (SWT). Gonzales Co.: *Lemke 2698* (SWT). Guadalupe Co.: *Roberts 168* (SWT). La Salle Co.: *Lake 19* (SWT). Llano Co.: Wallace *97* (SWT). Refugio Co.: *Jenkins 13* (SWT). Uvalde Co.: *Shepard 81* (SWT).

Chloris verticillata Nutt.

Texas. Bexar Co.: *Freeborn 208* (TEX-LL); *Rutledge 3* (TEX-LL). Bandera/Medina Co.: *Sanchez 626* (SWT). Blanco Co.: *Sanchez 781* (SWT). Dallam Co.: *Johnston & Walker 6835* (SWT). Hays Co.: *Heidemeyer 30* (SWT); Johnson 258 (TEX-LL). Llano Co.: *Emery 817* (TEX-LL). Scurry Co.: *Johnston 6533* (SWT). Travis Co.: *Dunlap 96* (TEX-LL), *Oefinger 306* (TEX-LL).

Chloris virgata Sw.

Texas. Baylor Co.: *Shinners 20764* (TEX-LL). El Paso Co.: *Hatch 5863* (SWT); *Worthington 17190* (SWT). Harris Co.: *Ward 1353* (SWT). Kimble Co.: *Sanchez 1036* (SWT). Travis Co.: *Brown 3273, 20529* (TEX-LL). Presidio Co.: *Foster 428* (SWT).

Coelorachis cylindrica (Michx.) Nash

Texas. Bastrop Co.: *Carr, Farquhar & Maresh 14649* (TEX-LL). Bee Co.: *Carr 12038* (TEX-LL). Hays Co.: *Carr 10681* (TEX-LL); *Sanders 4100* (TEX-LL). Kaufman Co.: *Bridges & Kindscher 13675* (TEX-LL). Llano Co.: *S.&G. Jones 3290* (SWT); *Wipff & Jones 1348, 1380* (TEX-LL). Parker Co.: *Carr et al. 15451* (TEX-LL). Tarrant Co.: *Carr 12816* (TEX-LL). Travis Co.: *Carr 18947* (TEX-LL).

Cynodon dactylon (L.) Pers.
Texas. Blanco Co.: *Margo 23* (TAES). Brazos Co.: *Knight 148* (SWT); *Snow 181* (SWT). Cameron Co.: *Lemke 574* (SWT). Culberson Co.: *Bierner 91-46* (SWT). Gillespie Co.: *Sanchez 995* (SWT). Gonzales Co.: *Keeble 16* (SWT). Guadalupe Co.: *Balcer 82* (SWT). Tom Green Co.: *Landers s.n.* (TAES). Travis Co.: *Ruiseco 209* (SWT). Washington Co.: *Polley 66,* (TAES). Williamson Co.: *Sutton 39* (TAES). Wilson Co.: *Smith 69* (SWT). Zavala Co.: *Dingee 51* (SWT).

Dactyloctenium aegyptium (L.) Willd.
Texas. Brazos Co.: *Donges et al. 9* (SWT); *Webster 1697* (TAES). Brown Co.: *Barton 34* (TAES). Caldwell Co.: *Lemke 790* (SWT). Galveston Co.: *Hatch 5755* (SWT). Jim Wells Co.: *Coffey 635* (TAES). Kleberg Co.: *Lemke 3005* (SWT). Nueces Co.: *Lemke 3331* (SWT). Wilson Co.: *Smith 71* (SWT).

Desmazeria rigida (L.) Tutin
Texas. Brazos Co.: *Gould 8643* (TAES); *Hatch 1663* (TEX-LL); *Knight 164* (SWT); *S.&G. Jones 1016* (TAES). Harris Co.: *Brown 20230* (TEX-LL). Hays Co.: *Hendrick 86* (SWT); *Ruiseco 50, 122* (SWT). Travis Co.: *Snow 219* (SWT). Washington Co.: *Lonard 2013* (TAES).

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark
Texas. Burnet Co.: *Johnston 6351* (SWT). Galveston Co.: *Yeargan 315* (SWT). Jasper Co.: *S.&G. Jones 2605* (SWT). Polk Co.: *Jones & Wipff 1469, 1481, 1496* (SWT). San Jacinto Co.: *Jones & Wipff 1446* (SWT). Shelby Co.: *S.&G. Jones & Nixon 1533* (SWT). Travis Co.: *Lemke 3636* (SWT).

Dichanthelium oligosanthes (Schult.) Gould
Texas. Angelina Co.: *Johnston 6671* (SWT). Bandera/Medina Co.: *Lackey 519* (SWT). Bastrop Co.: *Carr 6283* (SWT). Burleson Co.: *Toledo 23* (SWT). Cherokee Co.: *Johnston 6650* (SWT). Guadalupe Co.: *Ruiseco 141* (SWT). Hays Co.: *Pettingill 63* (SWT). Leon Co.: *Johnston 6704* (SWT). Real Co.: *Warnock 6811* (SWT). San Jacinto Co.: *S.&G. Jones 2480* (SWT). Smith Co.: *Johnston 6611* (SWT). Travis Co.: *Ruiseco 214* (SWT). Van Zandt Co.: *Johnston 6637* (SWT). Wood Co.: *S.&G. Jones 2757* (SWT).

Dichanthelium pedicellatum (Vasey) Gould
Texas. Bandera Co.: *Smith 496* (TEX-LL). Comal Co.: *Correll & Smith 29553* (TEX-LL). Kendall Co.: *Correll & Smith 29580* (TEX-LL). Travis Co.: *Carr 4709* (TEX-LL); *Mears 999* (TEX-LL); *Rodgers 6737* (TEX-LL); *Tharp 43164* (TEX-LL); *Warnock W1029* (TEX-LL). Uvalde Co.: *Gould 7675* (TEX-LL). Williamson Co.: *Carr 4032* (SWT).

Dichanthelium sphaerocarpon (Ell.) Gould
Texas. Anderson Co.: *Gould 14314* (TAES). Brazos Co.: *Northrup 15* (SWT); *Toledo 9* (SWT). Burleson Co.: *Knight & Miller 158* (SWT). Caldwell Co.: *Phillips 67* (SWT). Cass Co.: *Carr 9851* (SWT); *Johnston 6312* (SWT). Coryell Co.: *Wipff 261* (TAES). Franklin Co.: *Gould 14274* (TAES). Galveston Co.: *Clark 3039, 3058* (TAES). Houston Co.: *Jones & Wipff 1526* (SWT). Van Zandt Co.: *Carr 9768* (SWT).

Dichanthium annulatum (Forssk.) Stapf
Texas. Brazos Co.: *Troland 5* (SWT). Cameron Co.: *Lemke & Roberts 3034* (SWT). Coryell Co.: *Sanchez 1379* (SWT). Hidalgo Co.: *Lonard 4935* (SWT). Kenedy Co.: *Gould 11460* (TEX-LL). Nueces Co.: *Snow 189* (SWT). San Patricio Co.: *Lievens & Lievens 2909* (TEX-LL). Travis Co.: *Carr 17897* (TEX-LL). Val Verde Co.: *Carr et al. 12442* (TEX-LL).

Digitaria californica (Benth.) Henrard
Texas. Andrews Co.: *Scudday s.n.* (SWT). Archer Co.: *Gould 9771* (TAES). Brewster Co.: *Warnock s.n.* (SWT). Crane Co.: *McBryde 14956* (SWT). Gillespie Co.: *Epps 22* (TAES); *Snyder 29* (TAES). Hidalgo Co.: *Lonard 4977* (SWT). Kerr Co.: *Gould 8305* (TAES). Presidio Co.: *Warnock 14165* (SWT). Val Verde Co.: *Labus 346, 363* (SWT).

Digitaria ciliaris (Retz.) Koeler
Texas. Bastrop Co.: *Carr 9402* (TEX-LL); *Carr et al. 14938* (TEX-LL). Caldwell Co.: *Lemke 2677* (SWT). Cottle Co.: *Shinners 30357* (TEX-LL). Erath Co.: *Gould 10279* (TEX-LL). Grimes Co.: *Lemke 1941* (SWT). Hays Co.: *Breckenridge 513* (SWT). Hemphill Co.: *Rowell 4324* (TEX-LL). McLennan Co.: *S.&G. Jones 3217* (SWT). Parker Co.: *Lipscomb 2394* (TEX-LL). Robertson Co.: *Lemke 258* (SWT).

Digitaria cognata (Schult.) Pilg.
Texas. Bandera/Medina Co.: *Sanchez 648* (SWT). Burnet Co.: *Boylan 2* (SWT). Crockett Co.: *Warnock & McBryde 15282* (SWT). Fayette Co.: *Shepard 100* (SWT). Gillespie Co.: *Sanchez 1058* (SWT). Hays Co.: *Lyday 142, 148* (SWT); *Ruiseco 28* (SWT). Kaufman Co.: *Lemke 2524* (SWT). Kerr Co.: *Sanchez 1080* (SWT). Kinney Co.: *Rosen 224* (SWT). Rusk Co.: *Rosen & Jones 676* (SWT). Titus Co.: *Lemke 1246* (SWT).

Digitaria insularis (L.) Mez ex Ekman
Texas. Cameron Co.: *Runyon 5969* (TEX-LL). Dimmit Co.: *Gould 5798* (TAES); *Schroeder 40* (TAES). Hidalgo Co.: *Fleetwood 3137, 3309, 7066* (TEX-LL); *Lonard 4977* (TAES); *Tidwell 67* (TEX-LL). Kleberg Co.: *Johnston 541659* (TEX-LL). Travis Co.: *Brown F-2* (TEX-LL).

Digitaria patens (Swallen) Henrard
Texas. Bexar Co.: *Parks s.n.* (TAES); *Silveus 2415* (TEX-LL). Jim Wells Co.: *Coffey 236, 1207* (TAES). Kleberg Co.: *Gould 11450* (TAES); *Lundell 14870, 14952, 15006* (TEX-LL). Llano Co.: *Brown & Higdon s.n.* (TEX-LL); *Gould 8430* (TEX-LL). Travis Co.: *Brown 3520* (TEX-LL). Val Verde Co.: *Warnock & McBryde 15049* (SWT).

Digitaria sanguinalis (L.) Scop.
Texas. Austin Co.: *Galle 12* (TAES). Bexar Co.: *Silveus 2246* (TEX-LL). Brazoria Co.: *Huett 39* (TAES). Collingsworth Co.: *Tharp & Miller 51-355* (TEX-LL). Hays Co.: *Bailey 92* (SWT). Jack Co.: *Gould 10283* (TEX-LL). Jeff Davis Co.: *Keough 16* (TEX-LL); *Warnock 6688, 7471* (TEX-LL). Smith Co.: *Johnston 6618* (SWT).

Echinochloa colona (L.) Link
Texas. Bexar Co.: *Freeborn 205* (TEX-LL); *Hutzler 20* (SWT). Blanco Co.: *Baird s.n.* (TEX-LL). Crockett Co.: *Lemke 2623* (SWT). El Paso Co.: *Worthington 17187* (SWT). Hays Co.: *Breckenridge 441* (SWT). Hill Co.: *Gereau 25* (TEX-LL). Lee Co.: *Carr & Kutac 8797* (TEX-LL). Travis Co.: *Mears 565* (TEX-LL); *Oefinger 301* (TEX-LL); *Turner 63* (TEX-LL). Waller Co.: *Ayers 89* (TEX-LL). Williamson Co.: *Gordon 51-1760* (TEX-LL).

Echinochloa crus-galli (L.) P. Beauv.
Texas. Brazos Co.: *Seidensticker 116* (TAES). Carson Co.: *Johnston & Walker 6805* (SWT). Castro Co.: *Johnston & Walker 6886* (SWT). Comanche Co.: *Anders 15* (TEX-LL). Dallam Co.: *Johnston & Walker 6842* (SWT). El Paso Co.: *Worthington 17410* (TAES). Lamb Co.: *Johnston & Walker 6896* (SWT). Travis Co.: *Barrie 805* (TEX-LL); *Carr 4171* (TAES); *Carr & Brown 9234* (TEX-LL).

Echinochloa crus-pavonis (Kunth) Schult.
Texas. Brazoria Co.: *Rosen 632* (SWT). Burnet Co.: *Breckenridge 567* (SWT). Calhoun Co.: *Gould 11525a* (TEX-LL). Galveston Co.: *Waller & Bauml 2827* (TEX-LL); *Wortham 44* (TEX-LL). Hidalgo Co.: *Lonard 5012* (SWT). Hays Co.: *Lemke 2752* (SWT). Jefferson Co.: *Rosen 359, 380* (SWT). Llano Co.: *Butterwick & Lamb 3276* (TEX-LL).

Eleusine indica (L.) Gaertn.
Texas. Bexar Co.: *Silveus 179, 2226* (TAES). Brazos Co.: *Donges 39* (SWT); *Miller 54* (SWT). Fayette Co.: *Mikesky 7* (TAES). Galveston Co.: *Newcomb 14* (SWT). Gillespie Co.: *Sanchez 998* (SWT). Gonzales Co.: *Staton 36* (SWT). Hays Co.: *Alvarez 16* (SWT); *Burleson 25* (SWT); *Jessup 113* (SWT). Hidalgo Co.: *Lonard 4928* (TAES). Refugio Co.: *Lemke 746* (SWT).

Elymus canadensis L.
Texas. Bandera/Medina Co.: *Lackey 499* (SWT). Comal Co.: *Lemke 527* (SWT). Crockett Co.: *Lemke 2568* (SWT). Galveston Co.: *Rosen 315* (SWT). Gillespie Co.: *Kast 51* (TAES). Grimes Co.: *S.&G. Jones 1598* (TAES). Hays Co.: *Lemke 441* (SWT). Kerr Co.: *Clarke 2* (TAES); *May 5513* (TAES). Stonewall Co.: *Johnston & Walker 6775* (SWT). Uvalde Co.: *Lemke 2381* (SWT).

Elymus virginicus L.
Texas. Blanco Co.: *Sanchez 1393* (SWT). Brazoria Co.: *Dingee 78* (SWT), *Rosen & Jones 592* (SWT). Dallas Co.: *Nixon et al. 5550* (TAES). Fayette Co.: *Ramu et.al.* (TAES). Grimes Co.: *S.&G. Jones 1601* (SWT). Guadalupe Co.: *Bierner 91-23* (SWT). Hays Co.: *Ruiseco 69* (SWT). Live Oak Co.: *Lemke 2352* (SWT). San Patricio Co.: *Toledo 40* (SWT).

Eragrostis barrelieri Daveau
Texas. Blanco Co.: *Sanchez 838* (SWT). Burnet Co.: *Lemke 2033* (SWT). Comal Co.: *Lemke 757* (SWT). El Paso Co.: *Hatch 5851* (SWT); *Worthington 17595* (SWT). Hays Co.: *Alvarez 55* (SWT); *Beard 51* (SWT); *Breckenridge 458* (SWT); *Jessup 156* (SWT); *Thomas 84* (SWT). Hidalgo Co.: *Lemke 855* (SWT); *Lonard 4929* (SWT). Kerr Co.: *Sanchez 1077* (SWT). Sterling Co.: *Johnston & Walker 6968* (SWT). Val Verde Co.: *Labus 279, 312* (SWT); *Warnock & McBryde 15134* (SWT).

Eragrostis cilianensis (All.) Vignolo ex Janch.
Texas. Hidalgo Co.: *Lonard 5017* (SWT). Hays Co.: *Lemke 2903* (SWT). Kaufman Co.: *Lemke 2922* (SWT). Kerr Co.: *Gould 8309, 8467* (TAES); *Hatch 5066a* (SWT); *May 5522* (TAES). Kinney Co.: *Rosen 245* (SWT). Lampasas Co.: *Hamrick 70* (SWT). McLennan Co.: *S.&G. Jones 3216* (SWT). Travis Co.: *Snider 1* (TAES). Williamson Co.: *Otto 41* (TAES).

Eragrostis curtipendicellata Buckley
Texas. Archer Co.: *Johnston 6587* (SWT). Duvall Co.: *S.&G. Jones 890* (TAES). Ector Co.: *Warnock 15805* (SWT). Fayette Co.: *Ripple 51-1040* (TEX-LL). Gillespie Co.: *Nixon 28* (TEX-LL). Hidalgo Co.: *Lonard 5029* (SWT). Jim Wells Co.: *Coffey 391, 607, 633* (TAES). Karnes Co.: *Johnson 806* (TEX-LL). Lampasas Co.: *Hatch et al. 5813* (TEX-LL). Medina Co.: *Johnston et al. 3430* (TEX-LL).

Eragrostis curvula (Schrad.) Nees
Texas. Bandera Co.: *Brownlee 63-37* (TAES). Bexar Co.: *Diaz & Higdon H42* (TEX-LL); *Silveus 2156, 4663, 4683* (TEX-LL). Brazos Co.: *Aljoe 39* (SWT). Comanche Co.: *Gould 11434* (TEX-LL). Gillespie Co.: *S.&G. Jones 1301* (TAES). Henderson Co.: *Gould 10476* (TAES). Leon Co.: *S.&G. Jones 1545* (SWT). McLennan Co.: *Henard 64-44* (TAES). Parker Co.: *Carr et al. 14205* (TEX-LL).

Eragrostis intermedia Hitchc.
Texas. Bandera/Medina Co.: *Sanchez 645* (SWT). Culberson Co.: *Warnock 15942* (SWT). Gillespie Co.: *Sanchez 960* (SWT). Hays Co.: *Breckenridge 457* (SWT), *Jessup 57* (SWT), *Lemke 674* (SWT), *Lyday 281* (SWT), *Ruiseco 11* (SWT). , 197.: *Knight 180* (SWT). Val Verde Co.: *Labus 129, 197* (SWT).

Eragrostis lugens Nees
Texas. Aransas Co.: *Hays 206* (TAES). Bell Co.: *Wolff 481* (TAES). Harrison Co.: *Correll 35036* (TEX-LL). Karnes Co.: *Johnson 1287* (TAES). Refugio Co.: *Tharp s.n.* (SWT). Smith Co.: *Correll & Correll 32028* (TEX-LL). Taylor Co.: *Tracy 7928* (TEX-LL). Wichita Co.: *Mckee s.n.* (TEX-LL). Zapata Co.: *Lemke 1503* (SWT).

Eragrostis pectinacea (Michx.) Nees ex Steud.
Texas..: *Marsh 257* (TAES). DeWitt Co.: *Silveus 7804, 7815* (TEX-LL). Galveston Co.: *Waller & Bauml 3003* (TAES). Harris Co.: *Brown 2404* (TAES). Hays Co.: *Lemke 2899* (SWT). Llano Co.: *Gould 8436* (TEX-LL); *Tharp 43-23* (TEX-LL). Travis Co.: *Gould 7623* (TEX-LL).

Eragrostis reptans (Michx.) Nees
Texas. Anderson Co.: *Nixon et al. 3571* (TAES). Bexar Co.: *Silveus 925, 2468* (TEX-LL). Brazoria Co.: *Rosen & Jones 638* (SWT). Collin Co.: *Boylan 234* (SWT). Denton Co.: *Boylan 257* (SWT). Ellis Co.: *Green s.n.* (TAES). Hidalgo Co.: *Lonard 4971* (SWT). McMullen Co.: *Carr et al. 11314* (TEX-LL). Travis Co.: *Carr et al. 15599* (TEX-LL).

Eragrostis secundiflora J. Presl
Texas. Bastrop Co.: *Osborn 70* (SWT). Blanco Co.: *Sanchez 778, 933* (SWT). Guadalupe Co.: *Braswell 98* (SWT). Hays Co.: *Heidemeyer 29* (SWT). Kaufman Co.: *Lemke 2935* (SWT). Kenedy Co.: *Lundell & Correll 15236* (SWT). Kleberg Co.: *Barrientos s.n.* (SWT); *Lemke 2985* (SWT). Lee Co.: *Lemke 2962* (SWT). Llano Co.: *Wallace 98* (SWT). Nueces Co.: *Baker 4* (SWT); *Ruiseco 93* (SWT); *Smith 73* (SWT).

Eragrostis spectabilis (Pursh) Steud.
Texas. Cameron Co.: *S.&G. Jones 6105* (SWT). Gillespie Co.: *Sanchez 962* (SWT). Hays Co.: *Lemke 2908* (SWT). Kendall Co.: *Foster A-34* (TAES). Kerr Co.: *Sanchez 1095* (SWT). Lampasas Co.: *Colquitt et al. 10* (SWT). Milam Co.: *Spoonts 82020* (TAES). Robertson Co.: *Gould 7263, 11049* (TAES). Rusk Co.: *Rosen & Jones 680* (SWT).

Eragrostis superba Peyr.
Texas. Bastrop Co.: *Carr 14720* (TEX-LL). Brazos Co.: *Clark et al. 28* (SWT), *Emery 844* (TEX-LL), *Zieschang 21* (TAES). Llano Co.: *Breckenridge 561* (SWT), *S.&G. Jones & Wipff 3328* (SWT), *Lemke s.n.* (SWT), *Wipff 1384* (TEX-LL). Mason Co.: *Doell 24* (TAES). Menard Co.: *Crain 19* (TAES).

Eragrostis trichodes (Nutt.) Alph. Wood
Texas. Bexar Co.: *Oakley 1313* (SWT), *Silveus 7326* (TEX-LL). Brazos Co.: *Morden 124* (TAES). Leon Co.: *Jones & Wipff 2147* (TAES); *McLeod s.n.* (TAES); *Ruiseco & Phillips s.n.* (SWT). Lipscomb Co.: *Correll 30249* (TEX-LL). Randall Co.: *Higgins 9781* (TEX-LL). Travis Co.: *Warnock W1081* (TEX-LL).

Eriochloa contracta Hitchc.
Texas. Brazoria Co.: *Rosen 214* (SWT). Brazos Co.: *Gould 6141* (TEX-LL). Dallas Co.: *Galvan 38* (TAES). Galveston Co.: *Rosen 506* (SWT). Jim Wells Co.: *Johnston 542111* (TEX-LL). Jones Co.:

Johnston & Walker 6765 (SWT). Kerr Co.: *Gould 3800* (TAES). Nueces Co.: *Carr 11480, 11510* (TEX-LL). Victoria Co.: *Bownds 46* (TAES), *Hatch 4147* (TAES).

Eriochloa sericea (Scheele) Munro ex Vasey
Texas. Archer Co.: *Carr 15769* (TEX-LL). Bandera/Medina Co.: *Lackey 543* (SWT). Bee Co.: *Mayfield 2112* (TEX-LL). Bell Co.: *Wipff 208* (TAES). Cameron Co.: *Lonard 4995* (SWT). Hays Co.: *Morris 11* (SWT). Hidalgo Co.: *Lonard 4932* (SWT). Kerr Co.: *Drews 19* (TAES). Lampasas Co.: *Hatch 5808* (TEX-LL). Taylor Co.: *Johnston 6517* (SWT).

Erioneuron pilosum (Buckley) Nash
Texas. Blanco Co.: *Sanchez 883* (SWT). Edwards Co.: *Evans 20* (SWT). Gillespie Co.: *Sanchez 1405* (SWT). Hays Co.: *Lemke 477, 680* (SWT); *Lyday 26* (SWT). Kimble Co.: *Sanchez 1353* (SWT). Kinney Co.: *Rosen 217* (SWT). Llano Co.: *Lemke 694* (SWT). Sutton Co.: *Lemke 1677* (SWT). Uvalde Co.: *Lemke 963* (SWT). Val Verde Co.: *S.&G. Jones 8029* (SWT); *Labus 313* (SWT).

Festuca versuta Beal
Texas. Bexar Co.: *Carr 14571* (TEX-LL), *Carr & Diamond 14635* (TEX-LL). Blanco Co.: *Carr & Price 11088* (TEX-LL); *Sanchez 1392* (SWT). Hays Co.: *Carr 18869, 18871* (TEX-LL). Kendall Co.: *Carr & McNeal 11077* (TEX-LL). Kimble Co.: *Sanchez 1351, 1364* (SWT). Travis Co.: *Carr 18903, 18971* (TEX-LL).

Glyceria striata (Lam.) Hitchc.
Texas. Bell Co.: *Carr & Sanchez 17540* (TEX-LL); *Wolff 3242* (TAES). Blanco Co.: *Cory 41377* (TAES). Culberson Co.: *Lind s.n.* (TEX-LL); *Warnock 11927* (TEX-LL). Kendall Co.: *Breckenridge 581* (SWT); *Carr & McNeal 11080* (TEX-LL). Kerr Co.: *Parks & Cory s.n.* (TAES). Lamar Co.: *Carr & Wolfe 13692* (TEX-LL). Travis Co.: *Carr & Stone* (TEX-LL).

Heteropogon contortus (L.) P. Beauv.
Texas. Brewster Co.: *Warnock s.n.* (SWT). Burnet Co.: *Kutac & Lynch 7494* (TEX-LL). Cameron Co.: *Fleetwood 3679* (TEX-LL). El Paso Co.: *Warnock 14242* (SWT). Starr Co.: *Butterwick & Strong 1329* (TEX-LL). Uvalde Co.: *Carr & Mattiza 16769* (TEX-LL). Val Verde Co.: *Labus 267, 319* (SWT).

Hilaria belangeri (Steud.) Nash
Texas. Bandera/Medina Co.: *Sanchez 649* (SWT). Hays Co.: *Breckenridge 609* (SWT); *Lemke 697* (SWT); *Liang 108* (SWT). Kendall Co.: *Mattox 33* (SWT); *Seidensticker 141* (TAES). Kerr Co.: *Geier 59* (TAES). Kimble Co.: *Galle 25* (TAES); *Sanchez 1024* (SWT). Kinney Co.: *Rosen 221* (SWT). Menard Co.: *Clark 16* (TAES).

Hilaria mutica (Buckley) Benth.
Texas. Brewster Co.: *S.&G. Jones & Manrique 4045* (SWT). Crane Co.: *Warnock 15511* (SWT). Crockett Co.: *Warnock 15291* (SWT). El Paso Co.: *Worthington 17057* (SWT), *Worthington 18928* (SWT). Presidio Co.: *Morden 914* (TAES). Schleicher Co.: *Edmiston 14* (TAES). Scurry Co.: *Johnston 6525* (SWT). Sterling Co.: *Stroman 2046* (TAES). Val Verde Co.: *Labus 353* (SWT); *Warnock 15131* (SWT).

Hopia obtusua (Kunth) Zuloaga & Morrone
Texas. Bandera Co.: *Smith 663* (TEX-LL). Bandera/Medina Co.: *Sanchez 646* (SWT). Blanco Co.: *Johnson 286* (TEX-LL); *Sanchez 852* (SWT). Freestone Co.: *Probst 64* (TAES). Hays Co.: *Jessup 63* (SWT). Kerr Co.: *Sanchez 1082* (SWT). Leon Co.: *Nixon 17985* (TAES). Limestone Co.: *S.&G.*

Jones 1569 (TAES). Medina Co.: *Campos 16* (TAES). Real Co.: *Brown s.n.* (TEX-LL). Travis Co.: *Brown 3364* (TEX-LL); *Brown s.n.* (TEX-LL); *Lynch & Kutac 12110* (TEX-LL); *Tharp & York 50-132* (TEX-LL).

Hordeum murinum L.
Texas. Bexar Co.: *Silveus 20* (TEX-LL). Blanco Co.: *Sanchez 1176* (SWT); *Wipff et al. 80* (TAES). Brewster Co.: *Powell 6093* (TEX-LL); *Warnock s.n.* (SWT). Comal Co.: *Dodson 16* (SWT). Val Verde Co.: *Turner & Warnock 186* (TEX-LL). Williamson Co.: *S.&G. Jones 1231* (TAES); *Lonard 1845* (TAES).

Hordeum pusillum Nutt.
Texas. Bexar Co.: *Mayo 82* (SWT). Brazos Co.: *Toledo 5* (SWT). Edwards Co.: *Evans 27* (TAES); *Gould 11375* (TAES). Gillespie Co.: *Nixon & Brooks 35* (TAES). Grimes Co.: *Lemke 225* (SWT). Guadalupe Co.: *Shipman 91* (SWT). Hays Co.: *Ruiseco 55* (SWT). Kaufman Co.: *Valle 92* (SWT). Tom Green Co.: *Lemke 1631* (SWT). Travis Co.: *Queen 47* (SWT). Uvalde Co.: *Lemke 952, 2403* (SWT).

Hordeum vulgare L.
Texas. Culberson Co.: *Gould 12837* (TAES). Fort Bend Co.: *Knight 146* (SWT). Haskell Co.: *Cory 37158* (TEX-LL). Tom Green Co.: *Beede & Weatherwax s.n.* (TEX-LL). Travis Co.: *Pollock 4* (TAES). Washington Co.: *Carter 19* (TAES); *Osborn 41* (TAES).

Leersia oryzoides (L.) Sw.
Texas. Fannin Co.: *Correll 37968* (TEX-LL). Hays Co.: *Bruchmiller s.n.* (SWT); *Litchfield s.n.* (SWT). El Paso Co.: *Worthington 18292* (SWT). Jack Co.: *Carr 12870* (TEX-LL). Kerr Co.: *Carr & Price 15079* (TEX-LL). Travis Co.: *Brown 332* (TEX-LL), *Carr 15812* (TEX-LL), *Carr & Turner 15035* (TEX-LL). Wood Co.: *Nixon 14013* (SWT).

Leptochloa dubia (Kunth) Nees
Texas. Bandera/Medina Co.: *Sanchez 256* (SWT). Caldwell Co.: *Breckenridge 549* (SWT). Comal Co.: *Breckenridge 497* (SWT). El Paso Co.: *Worthington 17922* (SWT). Hays Co.: *Breckenridge 527, 535* (SWT); *Liang 71* (SWT); *Lyday 137* (SWT). Travis Co.: *Warnock & Warnock 5562* (SWT). Val Verde Co.: *Labus 347* (SWT).

Leptochloa fusca (L.) Kunth
Texas. Brazos Co.: *S.&G. Jones 1541* (TAES); *Snow & Jensen 184* (TEX-LL). Brewster Co.: *Correll 30691* (TEX-LL). Burnet Co.: *Carr et al. 9142* (TEX-LL). Cameron Co.: *Carr, Ettel & Williams 18149* (TEX-LL). Castro Co.: *Johnston & Walker 6888* (SWT). El Paso Co.: *Worthington 17425* (SWT). Galveston Co.: *Rosen & Yeargan 612* (SWT). Kleberg Co.: *Lemke 2995* (SWT). Llano Co.: *Butterwick & Lamb 2946* (TEX-LL). Nueces Co.: *Carr & Wolfe 16547* (TEX-LL); *Carr et al. 16868* (TEX-LL). Pecos Co.: *Kruse 203-42* (TAES). Randall Co.: *Carr 18471* (TEX-LL). Refugio Co.: *Hill 7699* (TAES). San Patricio Co.: *Mantique et al. 1729* (TAES). Travis Co.: *LaHue 49* (TAES). Webb Co.: *Ramirez 2* (TEX-LL). Williamson Co.: *Carr & Brown 9226* (TAES). Zapata Co.: *Snow 5901-D* (TEX-LL).

Leptochloa panicea (Retz.) Ohwi
Texas. Bastrop Co.: *Carr 8739* (TEX-LL). Brazos Co.: *S.&G. Jones 3424* (SWT); *Rosen & Jones 637* (SWT). Coleman Co.: *Bible 23* (TEX-LL). Hays Co.: *Breckenridge 499, 523* (SWT); *Mears 608* (TEX-LL). Jones Co.: *Johnston & Walker 6769* (SWT). Taylor Co.: *Tolstead 7557* (SWT). Travis Co.: *Carr 15589* (TEX-LL).

Limnodea arkansana (Nutt.) L.H. Dewey
Texas. Atascosa Co.: *Lemke 142* (SWT). Bandera/Medina Co.: *Lackey 517* (SWT). Brazos Co.: *Gould 15406* (SWT); *Knight & Knight 152* (SWT). Hays Co.: *Lemke et al. 2345* (SWT); *Ruiseco 49* (SWT). Kinney Co.: *Carr 10435* (SWT). San Augustine Co.: *Aljoe 19* (SWT); *George & Nixon 192* (SWT). Travis Co.: *Snow 180* (SWT). Uvalde Co.: *Lemke 1725* (SWT). Washington Co.: *Toledo 33* (SWT).

Lolium perenne L.
Texas. Angelina Co.: *S.&G. Jones 808* (SWT). Bandera/Medina Co.: *Lackey 523* (SWT). Bexar Co.: *Hagenbuch 29* (SWT); *Mayo 52* (SWT). Blanco Co.: *Atha 488* (SWT). Grimes Co.: *Hall 112* (SWT). Guadalupe Co.: *Bierner 91-22* (SWT). Travis Co.: *Queen 50* (SWT); *Suitt 60* (SWT); *Trevino 33* (SWT). Sabine Co.: *Lemke 995* (SWT). Washington Co.: *Aljoe 5* (SWT).

Lolium temulentum L.
Texas. Anderson Co.: *Gould 9521* (TEX-LL). Brazos Co.: *Gould 15411* (TAES). Caldwell Co.: *Lemke 452, 470* (SWT). Edwards Co.: *Gould 11379* (TEX-LL). Jack Co.: *Gould 10289* (TAES). Kimble Co.: *Lemke 2666* (SWT). Lamar Co.: *Shinners 14829* (TAES). McLennan Co.: *Smith g1115* (TEX-LL). Refugio Co.: *Gould 9891* (TEX-LL).

Melica nitens (Scribn.) Nutt. ex Piper
Texas. Bandera/Medina Co.: *Lackey 453* (SWT). Burnet Co.: *Morden 265* (SWT). Gillespie Co.: *Wipff et al. 112* (TAES). Hays Co.: *Dingee 89* (SWT). Kerr Co.: *Sanchez 1282* (SWT). Kimble Co.: *Sanchez 1054* (SWT). Medina Co.: *Barr 92-0011* (TAES). Travis Co.: *Lemke 3505* (SWT). Uvalde Co.: *Lemke 973* (SWT). Williamson Co.: *S.&G. Jones 1232* (TAES).

Muhlenbergia [illegible] (Buckley) Hitchc.
Texas. Brewster Co.: *Warnock W502* (TEX-LL). Culberson Co.: *Correll & Johnston 18543* (TEX-LL). Hudspeth Co.: *Butterwick & Lamb 2787* (TEX-LL); *Warnock & Johnston 16927* (TEX-LL). Jeff Davis Co.: *Manning 949* (TEX-LL); *Powell & Powell 4152* (TAES). Pecos Co.: *Tharp 43-492* (TEX-LL); *Warnock 13324, 46767* (TEX-LL). Sterling Co.: *Liles 29* (TAES). Terrell Co.: *Morden & Hatch 52* (TAES).

Muhlenbergia lindheimeri Hitchc.
Texas. Bandera/Medina Co.: *Lackey 275* (SWT). Bexar Co.: *Liles 17* (TAES). Blanco Co.: *Margo 21* (TAES); *Galvan 52* (TAES). Gillespie Co.: *Sanchez 976* (SWT). Hays Co.: *Breckenridge 538* (SWT); *Osborn 20* (SWT). Kendall Co.: *Mattox 37* (SWT). Kerr Co.: *Sanchez 1071* (SWT). Lampasas Co.: *Turner et al. 25* (SWT). Travis Co.: *Carr 3487* (SWT); *Dorr 2624* (TAES). Williamson Co.: *Otto 52* (TAES).

Muhlenbergia porteri Scribn. ex Beal
Texas. Brewster Co.: *Warnock 12784* (TAES). El Paso Co.: *Silveus 751* (TEX-LL); *Van Devender & McCarten s.n.* (TEX-LL). Jeff Davis Co.: *Keough 1212* (TEX-LL). Kerr Co.: *Cunningham 63-53* (TAES). Loving Co.: *Warnock 10689* (TEX-LL). Terrell Co.: *Johnston 6479* (SWT). Val Verde Co.: *Labus 348* (SWT); *Warnock & McBryde 15133* (SWT). Ward Co.: *Warnock 15783* (SWT).

Muhlenbergia reverchonii Vasey & Scribn.
Texas. Bandera/Medina Co.: *Sanchez 308, 642* (SWT). Bell Co.: *Sanchez 1430* (SWT). Blanco Co.: *S.&G. Jones 5993, 5996* (SWT). Hays Co.: *Breckenridge 516, 532, 537* (SWT); *S.&G. Jones 5720* (SWT); *Lemke 667* (SWT). Kerr Co.: *Sanchez 1102* (SWT). Travis Co.: *Bierner 90-213* (SWT); *Carr 3289* (SWT).

Muhlenbergia schreberi Gmel.
Texas. Anderson Co.: *Hatch 5083* (SWT). Grimes Co.: *Jones 3892* (SWT). Hays Co.: *Hatch 4396* (TAES). Houston Co.: *Hatch 6173* (SWT). Kerr Co.: *Clarke 41* (TAES). Kimble Co.: *Sanchez 1044* (SWT). Real Co.: *Silveus 633* (TAES). Robertson Co.: *Gould 7613* (TAES); *Morden 531* (SWT). Travis Co.: *Carr et al. 9320* (SWT).

Muhlenbergia utilis (Torr.) Hitchc.
Texas. Bandera Co.: *Morden 553* (TAES). Blanco Co.: *Brown 2908* (TAES), *Carr & McNeal 10911* (TEX-LL); *Sanchez 917* (SWT); *Silveus 5451* (TEX-LL). Gillespie Co.: *Morden 544* (TAES). Kerr Co.: *Higdon 29* (TEX-LL). Llano Co.: *Poole 2552* (TEX-LL). Terrell Co.: *Silveus 659* (TEX-LL). Travis Co.: *Carr 18653* (TEX-LL); *Carr & Maresh 18646* (TEX-LL).

Muhlenbergia ×involuta Swallen
Texas. Bandera Co.: *Silveus 7393* (TAES). Bexar Co.: *Carr 18604* (TEX-LL); *Carr & Barwick 18604* (TEX-LL). Blanco Co.: *Barnett 1* (TEX-LL); *Breckenridge 558* (SWT). Hays Co.: *Niemann 38-62* (TAES). Kendall Co.: *Silveus 780* (TAES). Travis Co.: *Brown 50-323* (TEX-LL); *Moon 167* (TEX-LL).

Nassella leucotricha (Trin. & Rupr.) R.W.Pohl
Texas. Bandera/Medina Co.: *Lackey 427, 491* (SWT). Bee Co.: *Lemke 2245* (SWT). Blanco Co.: *Ramirez 194* (SWT). Brazoria Co.: *Rosen 566* (SWT). Fort Bend Co.: *Knight 141* (SWT). Gillespie Co.: *S.&G. Jones 6625* (SWT). Hays Co.: *Litchfield s.n.* (SWT); *Lyday 312* (SWT). Jeff Davis Co.: *S.&G. Jones 6581* (SWT). Kerr Co.: *Sanchez 1246* (SWT). Llano Co.: *S.&G. Jones 6597* (SWT). McMullen Co.: *Lemke 1600* (SWT). Sutton Co.: *Mitchell 54* (SWT). Travis Co.: *Snow 188* (SWT). Uvalde Co.: *Lemke 936* (SWT).

Panicum antidotale Retz.
Texas. Brewster Co.: *Johnston et al. 10586* (TEX-LL); *Riskind 1858* (TEX-LL). Cameron Co.: *Runyon 5985* (TAES). Duval Co.: *Hatch 5267* (SWT). Frio Co.: *S.&G. Jones 1693* (TAES). Hidalgo Co.: *Correll 36765* (TEX-LL), *Fleetwood 3300* (TEX-LL). Kerr Co.: *Kast 60* (TAES). Uvalde Co.: *Breckenridge 621* (SWT). Williamson Co.: *Price 6* (TAES). Zapata Co.: *Shinners 30854* (TEX-LL).

Panicum capillare L.
Texas. Archer Co.: *Johnston 6586* (SWT). Bosque Co.: *S.&G. Jones 3243* (SWT). Castro Co.: *Johnston & Walker 6885* (SWT). Dallam Co.: *Johnston & Walker 6831* (SWT). Donley Co.: *Johnston & Walker 6784* (SWT). Hays Co.: *Breckenridge 518* (SWT). Jones Co.: *Johnston & Walker 6763* (SWT). Lamb Co.: *Johnston & Walker 6895* (SWT). Stonewall Co.: *Johnston & Walker 6778* (SWT).

Panicum coloratum L.
Texas. Bandera/Medina Co.: *Sanchez 585* (SWT). Bexar Co.: *Silveus 7203* (TEX-LL). Gillespie Co.: *Kast 52* (TAES). Guadalupe Co.: *Carr & Turner 12979* (TEX-LL). Hays Co.: *Jessup 53* (SWT); *Sanchez 1410* (SWT). Kleberg Co.: *Perdue 1891, 1895* (TEX-LL). Lampasas Co.: *Hatch 5847* (TEX-LL). Menard Co.: *Clark 49* (TAES).

Panicum hallii Vasey
Texas. Blanco Co.: *Lackey 777* (SWT). Brewster Co.: *Johnston 6426* (SWT). Crockett Co.: *Lemke 2549* (SWT). Hays Co.: *S.&G. Jones 5710* (SWT); *Monahan 25* (SWT); *Preistle 7* (SWT). Kimble Co.: *Sanchez 1026* (SWT). Llano Co.: *Breckenridge 560* (SWT). San Augustine Co.: *George & Nixon 100* (SWT). Tom Green Co.: *Namken 17* (SWT). Val Verde Co.: *Labus 301, 326, 352* (SWT).

Panicum virgatum L.
Texas. Blanco Co.: *Breckenridge 559* (SWT). Colorado Co.: *Breckenridge 605* (SWT). Harris Co.: *Nixon 16093* (SWT). Kendall Co.: *Breckenridge 582* (SWT). Hays Co.: *Bierner 90-208* (TEX-LL). Hunt Co.: *Sanders 3333, 3377, 3718, 3744* (TEX-LL). Kimble Co.: *Hatch 5060* (SWT). Lampasas Co.: *Hatch 5843* (TEX-LL). Menard Co.: *Simpson s.n.* (TEX-LL). Val Verde Co.: *Smith & Butterwick 202* (TEX-LL).

Pappophorum bicolor E. Fourn.
Texas. Cameron Co.: *Lemke 1485* (SWT). Duval Co.: *Hatch 5264* (SWT). King Co.: *Grayum 16* (TAES). Nueces Co.: *Gould 10957* (TAES). Reagan Co.: *Lemke 2580* (SWT). Uvalde Co.: *Shepard 79* (SWT). Val Verde Co.: *Labus 20, 196, 269* (SWT) *Lemke 1682* (SWT). Zapata Co.: *Lemke 1525* (SWT). Zavala Co.: *Adams 59* (SWT); *Casey 64* (SWT).

Pappophorum vaginatum Buckley
Texas. Brewster Co.: *Bierner 91-41* (TEX-LL); *Turner & Turner 21-907* (TEX-LL). Cameron Co.: *Lonard 5002* (SWT); *Van Fleet 7002* (TEX-LL). Kleberg Co.: *Carr 11453* (TEX-LL). Reeves Co.: *Turner 2974* (TEX-LL). Webb Co.: *Perez 66* (TEX-LL); *Ramirez 1* (TEX-LL).

Paspalum dilatatum Poir.
Texas. Bandera/Medina Co.: *Lackey 262* (SWT). Blanco Co.: *Sanchez 774* (SWT). Brazos Co.: *Snow 185* (SWT). Caldwell Co.: *Lemke 453* (SWT). Calhoun Co.: *Nuckels 1* (TAES). Fort Bend Co.: *Knight 144* (TAES). Grimes Co.: *Lemke 215, 1934* (SWT). Kimble Co.: *Sanchez 1049* (SWT). Medina Co.: *Gwaltney 31* (TAES). Polk Co.: *Hatch 6546* (TAES); *Jones & Wipff 1454* (SWT).

Paspalum distichum L.
Texas. Brazos Co.: *Shah S-16* (TAES). Galveston Co.: *Rosen 539* (TAES); *Waller & Bauml 3097* (SWT). El Paso Co.: *Worthington 17318* (TAES). Hays Co.: *Jessup 17* (SWT); *Johnson 429* (TEX-LL). Hemphill Co.: *Rowell 4162* (TEX-LL). Llano Co.: *S.&G. Jones & Wipff 3318* (SWT). McMullen Co.: *Carr et al. 11311* (TEX-LL). Randall Co.: *Carr 18468* (TEX-LL). Travis Co.: *Carr & McNeal 12850* (TEX-LL).

Paspalum pubiflorum Rupr. ex E. Fourn.
Texas. Bandera Co.: *Smith 634* (TEX-LL). Hays Co.: *Litchfield s.n.* (SWT); *Tharp s.n.* (SWT). Hidalgo. *Lonard 4933* (SWT). Kinney Co.: *Correll & Ogden 25090-A* (TEX-LL). Llano Co.: *Butterwick & Lamb 2912, 3331* (TEX-LL). Travis Co.: *Carr 4333* (TEX-LL); *Nee & Whelan* (TEX-LL); *Wendt 6990* (TEX-LL).

Paspalum setaceum Michx.
Texas. Galveston Co.: *Hatch 5743* (SWT). Gillespie Co.: *Nixon & Brooks 105* (TAES). Hays Co.: *Ruiseco 12* (SWT). Kenedy Co.: *Lemke 544* (SWT). Kleberg Co.: *Lemke 3145* (SWT). San Augustine Co.: *George & Nixon 33* (SWT). San Jacinto Co.: *Barbee 33* (TAES). San Patricio Co.: *Aljoe 26* (SWT). Starr Co.: *Margo 18* (TAES).

Paspalum urvillei Steud.
Texas. Bandera/Medina Co.: *Sanchez 640* (SWT). Blanco Co.: *Sanchez 887* (SWT). Fort Bend Co.: *Breckenridge 595* (SWT). Galveston Co.: *Rosen 293* (SWT). Harris Co.: *Nixon 16082* (SWT). Hays Co.: *Litchfield s.n.* (SWT). Jefferson Co.: *Crockett 8638* (SWT). Kendall Co.: *Breckenridge 583* (SWT). Leon Co.: *Daniel et al. 9* (SWT). Titus Co.: *Lemke 1290* (SWT).

Pennisetum ciliare (L.) Link
Texas. Caldwell Co.: *Breckenridge 555* (SWT). Cameron Co.: *Lemke 575* (SWT). Dimmit Co.: *Lemke 1893* (SWT). Hidalgo Co.: *Hook 16* (SWT); *S.&G. Jones 864* (SWT); *Lemke 853, 888* (SWT). Live Oak Co.: *Bohls 25* (SWT). Starr Co.: *Lemke 861* (SWT). Val Verde Co.: *Labus 316* (SWT). Zapata Co.: *Lemke 1514* (SWT).

Phalaris caroliniana Walt.
Texas. Atascosa Co.: *Lemke 144* (SWT). Blanco Co.: *Wipff et al 73* (TAES). Childress Co.: *Spoonts 82013* (TAES). Fayette Co.: *Ramu et al. 40* (TAES). Frio Co.: *Lemke 2370* (SWT). Lampasas Co.: *S.&G. Jones 1246* (SWT). McCulloch Co.: *Hatch 6252* (TAES). San Patricio Co.: *Lemke 834* (SWT). Uvalde Co.: *Lemke 1818* (SWT). Zavala Co.: *Shepard 47* (SWT).

Phragmites australis (Cav.) Trin. ex Steud.
Texas. Armstrong Co.: *Rowell 5352* (TEX-LL). Brazoria Co.: *Rosen & Hatch et al. 489* (SWT). Brewster Co.: *Correll & Correll 35388* (TEX-LL). Galveston Co.: *Breckenridge 598* (SWT); *Hatch 5753* (SWT); *Schmidt 45* (SWT). Grayson Co.: *Nee & Diggs 43898* (TEX-LL). McCulloch Co.: *Hatch 6252* (TAES). Oldham Co.: *Smith 125* (TEX-LL).

Poa annua L.
Texas. Brazoria Co.: *Dingee 34* (SWT). Brazos Co.: *Toledo 4* (SWT). Caldwell Co.: *Lemke 2166* (SWT). Comal Co.: *Behrends 23* (SWT). DeWitt Co.: *Logeman 7* (SWT). Galveston Co.: *Rosen 524* (SWT). Gillespie Co.: *Weidenfeller 96* (SWT). Lavaca Co.: *Queen 30* (SWT). Travis Co.: *Snow 175* (SWT); *Stefani 49* (SWT); *Suitt 72* (SWT).

Poa arachnifera Torr.
Texas. Blanco Co.: *Wipff 95, 105* (TAES). Burleson Co.: *Morden 236* (SWT). Caldwell Co.: *Adair 16* (TAES). Coryell Co.: *Sanchez 1445* (SWT). Gillespie Co.: *Correll & Johnston 21174* (TEX-LL). Lampasas Co.: *S.&G. Jones 1265* (SWT). McLennan Co.: *Holmes 5651* (SWT). Tom Green Co.: *Namken 29* (SWT). Travis Co.: *Carr 6238* (TAES). Williamson Co.: *Lonard 2012* (TAES).

Polypogon monspeliensis (L.) Desf.
Texas. Atascosa Co.: *Lemke 170* (SWT). Bandera/Medina Co.: *Lackey 551* (SWT). Brazos Co.: *Gould & Hycka 7988* (TEX-LL); *Hatch 4113* (TEX-LL); *S.&G. Jones 1535* (SWT); *Snow 183* (SWT). Burleson Co.: *Gould & Celerier 5450* (TEX-LL); *Morden 236* (TEX-LL). Galveston Co.: *Toledo 10* (SWT). Jeff Davis Co.: *Bierner 37* (SWT). McLennan Co.: Holmes *3651* (TEX-LL). Medina Co.: *Lemke 1737* (SWT). Travis Co.: *Brown s.n.* (TEX-LL); *Carr 6238* (TEX-LL).

Polypogon viridis (A. Gouan) M. Breistr.
Texas. Bandera Co.: *Smith 554* (TEX-LL). Brewster Co.: *Warnock 776* (TEX-LL). Culberson Co.: *Lind s.n.* (TEX-LL). El Paso Co.: *Worthington 5421* (TEX-LL). Freestone Co.: *Do 543* (TEX-LL). Gillespie Co.: *Nixon 48* (TEX-LL). Jeff Davis Co.: *Bierner 91-38* (SWT). Presidio Co.: *Butterwick & Strong 883a* (TEX-LL). Travis Co.: *Nee & Whelan 11823* (TEX-LL).

Schedonnardus paniculatus (Nutt.) Trel.
Texas. Archer Co.: *Johnston 6589* (SWT). Blanco Co.: *Kelley 3* (TAES). Coryell Co.: *Sanchez 1421* (SWT). Hays Co.: *Bailey 94* (SWT); *Jessup 124* (SWT). Kendall Co.: *Seidensticker 127* (TAES). Medina Co.: *S.&G. Jones 1783* (TAES). Red River Co.: *S.&G. Jones 2866* (SWT). Swisher Co.: *Johnston 6572* (SWT).

Schizachyrium scoparium (Michx.) Nash
Texas. Bandera/Medina Co.: *Lackey 323* (SWT). Blanco Co.: *Sanchez 954* (SWT). Brazoria Co.: *Rosen 697* (SWT). Caldwell Co.: *Lemke 769* (SWT). Comal Co.: *Breckenridge 498* (SWT). Edwards Co.: *Evans 35* (SWT). Hays Co.: *Lyday 147* (SWT). Kerr Co.: *Sanchez 1066* (SWT). Robertson Co.: *Lemke 3343* (SWT). Travis Co.: *Bierner 90-212* (SWT); *Warnock & Warnock 5566* (SWT).

Setaria grisebachii E. Fourn.
Texas. Brewster Co.: *Hinkley & Hinkley 226* (TEX-LL); *Powell & Powell 6257* (TEX-LL). Edwards Co.: *Correll 31552* (TEX-LL). El Paso Co.: *Worthington 17328, 17376* (TAES). Jeff Davis Co.: *Correll 34991* (TEX-LL); *Keough 38* (TEX-LL); *Warnock 22593* (TEX-LL). San Saba Co.: *Ellis 218* (TAES). Val Verde Co.: *Warnock 11687* (TEX-LL); *Warnock & McBryde 15151* (SWT).

Setaria leucopila (Scribn. & Merr.) K. Schum.
Texas. Brewster Co.: *S.&G. Jones 6541* (SWT). El Paso Co.: *Hatch 5862* (SWT); *Worthington 17058* (SWT). Hardeman Co.: *Carr 9811* (SWT). Hays Co.: *Breckenridge 490* (SWT); *Tabler s.n.* (SWT). Hidalgo Co.: *Lonard 4921* (SWT). Medina Co.: *Gwaltney 29* (TAES). Pecos Co.: *Brown 1253* (TAES). Tom Green Co.: *Morgan 56* (SWT). Travis Co.: *Allred 1447* (TAES); *LaHue 44* (TAES).

Setaria parviflora (Poir.) Kerguélen
Texas. Anderson Co.: *Nixon 14129* (SWT). Bandera/Medina Co.: *Lackey 281* (SWT). Blanco Co.: *Sanchez 849, 897* (SWT). Brazoria Co.: *Rosen 205* (SWT). Caldwell Co.: *Breckenridge 545* (SWT). Fort Bend Co.: *Breckenridge 596* (SWT). Galveston Co.: *Rosen 480* (SWT); *Rosen & Jones 601* (SWT). Gonzales Co.: *Lemke 2687* (SWT). Grayson Co.: *Boylan 420* (SWT). Hays Co.: *Lemke 2746* (SWT).

Setaria pumila (Poir.) Roem. & Schult.
Texas. Bexar Co.: *Morris 44* (SWT). Brown Co.: *Hewitt 1* (TEX-LL). Galveston Co.: *Waller 3798* (TEX-LL). Hays Co.: *Beard 29* (SWT). Real Co.: *Smith & Butterwick 290* (TEX-LL). San Patricio Co.: *Hatch 4136* (TEX-LL). Shelby Co.: *Rosen & Jones 683* (SWT). Walker Co.: *Carr 13268* (TEX-LL). Wise Co.: *Lemke 609* (SWT).

Setaria reverchonii (Vasey) Pilger
Texas. Bandera/Medina Co.: *Lackey 542* (SWT). Bell Co.: *Coffey 1726* (TAES). Bexar Co.: *Silveus 7606* (TAES). Brewster Co.: *S.&G. Jones & Manrique 463* (SWT). Brown Co.: *Harris 142* (SWT). Comal Co.: *Liles 10* (TAES). Coryell Co.: *Wipff 226* (SWT). Donley Co.: *Johnston & Walker 6786, 6795* (SWT). Frio Co.: *Gould 11281* (TAES). Lampasas Co.: *Jones 40* (SWT). Shackelford Co.: *Johnston 6602* (SWT).

Setaria scheelei (Steud.) Hitchc.
Texas. Bandera/Medina Co.: *Lackey 324* (SWT). Bexar Co.: *Liles 36* (TAES). Blanco Co.: *Sanchez 822, 945* (SWT). Hays Co.: *Neimann 18-62* (TAES); *Priestle 73* (SWT); *Reardon 76* (TAES); *Thomas 83* (SWT). Kimble Co.: *Sanchez 1039* (SWT). Llano Co.: *Gould 8432* (TAES); *Heinemann 63-25* (TAES); *Wallace 12* (SWT). Travis Co.: *Carr 3344* (TAES); *Elam 38* (TAES). Uvalde Co.: *Bownds 8* (TAES).

Setaria verticillata (L.) P. Beauv.
Texas. Brewster Co.: *Hatch & Morden 4325A* (TAES); *Morden & Hatch 62* (TAES); *Warnock 9120* (TEX-LL). Cameron Co.: *Carr et al. 13328* (TEX-LL); *Fleetwood 3744* (TEX-LL). El Paso Co.: *Worthington 17416* (SWT). Hidalgo Co.: *Lonard 3289* (TAES), *Lonard 5023* (SWT). Nueces Co.: *Jones 4229* (TEX-LL).

Setaria villosissima (Scribn. & Merr.) K. Schum.
Texas. Gillespie Co.: *Emery 444, 445, 447, 448, 455, 458, 464, 465* (TEX-LL); *Silveus 2337* (TAES). Llano Co.: *Emery 475, 591* (TEX-LL).

Setaria viridis (L.) P. Beauv.
Texas. Crockett Co.: *Lemke 2632* (SWT). Edwards Co.: *Evans 25* (TAES). Hays Co.: *Liang 50* (SWT); *Osborn 35* (SWT). Jeff Davis Co.: *Morden & Hatch 86* (TAES); *Worthington 13760* (SWT). Kinney Co.: *Rosen 233, 253* (SWT). Tyler Co.: *S.&G. Jones 3691* (SWT). Williamson Co.: *S.&G. Jones 1831* (SWT); *S.&G. Jones 3016* (TAES).

Sorghastrum nutans (L.) Nash
Texas. Anderson Co.: *Nixon 14127* (SWT). Brazoria Co.: *Rosen 696* (SWT). Fayette Co.: *Lemke 2000* (SWT). Hays Co.: *Lemke 2716* (SWT). Kaufman Co.: *Lemke 2939* (SWT). Kendall Co.: *Breckenridge 578, 579.* Kerr Co.: *Bownds 16* (TAES). McLennan Co.: *Henard 64-31* (TAES). Robertson Co.: *Lemke 3345* (SWT). Travis Co.: *Carr 4387* (TAES).

Sorghum bicolor (L.) Moench
Texas. Blanco Co.: *Sanchez 908* (SWT). Brazoria Co.: *Jordon s.n.* (TEX-LL). Brazos Co.: *Morden 1036* (TAES). Denton Co.: *Boylan 264* (SWT). Galveston Co.: *Morden 114* (TAES). Harris Co.: *Treverse 1318* (TEX-LL). Hidalgo Co.: *Crockett 8022* (SWT); *Leal 27* (TAES). Kimble Co.: *Turner 97-500* (TEX-LL). Presidio Co.: *Correll & Rollins 23690* (TEX-LL).

Sorghum halepense (L.) Pers.
Texas. Bandera/Medina Co.: *Lackey 549* (SWT). Blanco Co.: *Sanchez 789* (SWT). Brewster Co.: *Warnock s.n.* (SWT). Burnet Co.: *Adams 19* (SWT). Comal Co.: *Schoolcraft 104* (SWT). Crockett Co.: *Lemke 2571* (SWT). Fayette Co.: *Lemke 1996* (SWT). Hays Co.: *Burleson 19* (SWT). Wharton Co.: *Losack 76* (SWT).

Sphenopholis obtusata (Michx.) Scribn.
Texas. Angelina Co.: *Jones & Powell* (SWT). El Paso Co.: *Worthington 14125, 17954* (SWT). Fort Bend Co.: *Knight 140* (SWT). Gonzales Co.: *Carr 7271* (SWT). Liberty Co.: *Hatch 4717* (SWT). Polk Co.: *Jones & Wipff 1467* (SWT). San Patricio Co.: *Toledo 54* (SWT). Wood Co.: *S.&G. Jones & Powell 2764* (SWT).

Sporobolus airoides (Torr.) Torr.
Texas. Brewster Co.: *S.&G. Jones 6542* (SWT). Crane Co.: *Powell 2376* (TEX-LL). Culberson Co.: *Burgess 814* (TAES). Dallam Co.: *Gould & Thomas 7137* (TEX-LL). El Paso Co.: *Walsh 19a* (TAES); *Worthington 17180* (SWT). Harris Co.: *Brown 9422* (TEX-LL). Presidio Co.: *McWilliams 6* (TAES); *Ohlendorf 773* (TAES); *York 48261* (TEX-LL). Travis Co.: *Brown D-4* (TEX-LL).

Sporobolus clandestinus **(Biehler) Hitchc.**
Texas. Hays Co.: *S.&G. Jones 5713* (TAES); *Ruiseco 34* (SWT). Houston Co.: *S.&G. Jones & Wipff 5798* (SWT). Rusk Co.: *Rosen & Jones 674* (SWT).

Sporobolus compositus (Poir.) Merr.
Texas. Brown Co.: *Black 229* (SWT). Coryell Co.: *Sanchez 1420* (SWT). Gillespie Co.: *Sanchez 990, 1604.* Hays Co.: *Breckenridge 462, 504, 505, 526, 533* (SWT); *S.&G. Jones 5713* (SWT); *Ruiseco 34* (SWT). San Augustine Co.: *George & Nixon 165* (SWT). Val Verde Co.: *Labus 300* (SWT).

Sporobolus cryptandrus (Torr.) A. Gray
Texas. Cameron Co.: *Lemke 573* (SWT). El Paso Co.: *Worthington 17419* (SWT). Glasscock Co.: *Johnston & Walker 6966* (SWT). Jones Co.: *Johnston & Walker 6766* (SWT). Kimble Co.: *Sanchez 1037* (SWT). Kinney Co.: *Rosen 223* (SWT). Lavaca Co.: *Johnston 6729* (SWT). Lee Co.: *S.&G. Jones 3351* (SWT). Live Oak Co.: *Bohls 24* (SWT). Winkler Co.: *S.&G. Jones 7458* (SWT).

Sporobolus pyramidatus (Lam.) Hitchc.
Texas. Aransas Co.: *Hays 151* (TAES). Brazos Co.: *Fox 69* (SWT). Calhoun Co.: *Harvey 7585* (TAES). Fayette Co.: *Knight 176* (SWT). Hays Co.: *Rosen et al. 1172* (SWT). Jackson Co.: *Lemke 2898* (SWT). Karnes Co.: *Davidson 12* (TAES). Kleberg Co.: *Lemke 3006* (SWT). Nueces Co.: *Lemke 3333* (SWT). San Patricio Co.: *Toledo 46* (SWT). Victoria Co.: *Budd 54* (TAES).

Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood
Texas. Blanco Co.: *Sanchez 916* (SWT). Caldwell Co.: *Lemke 2019* (SWT). Carson Co.: *Johnston & Walker 6806* (SWT). Comal Co.: *Breckenridge 493* (SWT); *Lemke 755* (SWT). Gillespie Co.: *Sanchez 957* (SWT). Hays Co.: *S.&G. Jones 5712* (SWT); *Lyday 291* (SWT). Kerr Co.: *Hatch 4712* (SWT); *Sanchez 1063* (SWT). Kimble Co.: *Sanchez 1045* (SWT).

Steinchisma hians (Ell.) Nash
Texas. Brazoria Co.: *Amestoy 88* (TAES); *Campbell 22* (TAES). Brazos Co.: *Knight 181* (SWT). Freestone Co.: *Probst 64* (TAES). Galveston Co.: *Rosen 574* (SWT); *Waller 2680* (SWT). Grimes Co.: *Lemke 172, 221* (SWT). Jefferson Co.: *Crockett 6871* (SWT). Lamar Co.: *Johnston 6277* (SWT). Lavaca Co.: *Nuckels 55* (TAES). Leon Co.: *Nixon 17911, 17985* (TAES). San Patricio Co.: *Aljoe 22* (SWT). Victoria Co.: *Budd 44* (TAES); *Chandler 50* (TAES).

Stenotaphrum secundatum (Walt.) Kuntze
Texas. Brazos Co.: *Junkin 75* (TAES). Caldwell Co.: *Lemke 2678* (SWT). Edwards Co.: *Butterwick & Smith 459* (TEX-LL). Galveston Co.: *Waller et al. 2825* (TEX-LL). Hays Co.: *Litchfield s.n.* (SWT). Hidalgo Co.: *Lonard 4916* (SWT). Matagorda Co.: *Cecora 16-C* (TAES). Nueces Co.: *Carr & Wolfe 16396* (TEX-LL). San Patricio Co.: *Toledo 52* (SWT). Travis Co.: *Henard 64-59* (TAES).

Tragus berteronianus Schult.
Texas. Brooks Co.: *Tharp s.n.* (TEX-LL). Burnet Co.: *Breckenridge 618* (SWT). Culberson Co.: *Reeder & Reeder 5932* (TEX-LL). Gillespie Co.: *Parks s.n.* (TAES). Jim Hogg Co.: *Tharp 5237* (SWT). Jim Wells Co.: *Barton 64* (TAES). Llano Co.: *Butterwick & Lamb 3041* (TEX-LL); *Gould 8435* (TEX-LL); *Wipff & Jones 1355* (TEX-LL). San Patricio Co.: *Bownds 41* (TAES). Webb Co.: *Trevino 11* (TEX-LL).

Tridens albescens (Vasey) Wooton & Standl.
Texas. Bandera/Medina Co.: *Lackey 516* (SWT). Bee Co.: *Lemke 2243* (SWT). Blanco Co.: *Sanchez 885* (SWT). Brown Co.: *Capo 17* (SWT). Caldwell Co.: *Breckenridge 550* (SWT). Dimmit Co.: *Lemke 1880* (SWT). Fayette Co.: *Aljoe 2* (SWT). Kendall Co.: *Breckenridge 575* (SWT). Kerr Co.: *Sanchez 1094* (SWT). McMullen Co.: *Lemke 1602* (SWT). Tom Green Co.: *Lemke 1632* (SWT). Val Verde Co.: *Labus 145, 253* (SWT).

Tridens buckleyanus (L.H. Dewey) Nash
Texas. Bexar Co.: *Carr & Price* 12370, 12376 (TEX-LL). Hays Co.: *Carr & Johnston 17754* (TEX-LL). Kendall Co.: *Carr et al. 12984* (TEX-LL). Travis Co.: *Carr 6150, 6164, 9261* (SWT); *Carr 11121, 18643* (TEX-LL); *Hatch 5828* (TEX-LL); *Johnston s.n.* (TEX-LL).

Tridens eragrostoides (Vasey & Scribn.) Nash
Texas. Cameron Co.: *Carr 14411* (TEX-LL); Correll *& Rollins 20970* (TEX-LL); *Fleetwood 3508, 3775* (TEX-LL). Hays Co.: *Tharp s.n.* (TEX-LL). Karnes Co.: *Johnson 883* (TEX-LL). Kinney Co.: *Moore et al. 8854* (TEX-LL). Kleberg Co.: *Carr 11562* (TEX-LL); *Johnston 54380* (TEX-LL). Uvalde Co.: *Reverchon 1617* (TEX-LL). Webb Co.: *Martinez & Trevino 9* (TEX-LL).

Tridens flavus (L.) Hitchc.
Texas. Donley Co.: Johnston *& Walker 6793* (SWT). Gillespie Co.: *Sanchez 992* (SWT). Houston Co.: *Hatch 6165* (SWT); *Rosen & Jones 642* (SWT). Kerr Co.: *Sanchez 1085* (SWT). Kimble Co.: *Sanchez 1047* (SWT). Robertson Co.: *Lemke 3351* (SWT). San Augustine Co.: *George & Nixon 87* (SWT). Titus Co.: *Lemke 1248* (SWT).

Tridens muticus (Torr.) Nash
Texas. Bandera/Medina Co.: *Sanchez 647* (SWT). Burnet Co.: *Lemke 2036* (SWT); *Pollok 8* (SWT). Comal Co.: *Breckenridge 496* (SWT). Duval Co.: *S.&G. Jones 894* (SWT). Hays Co.: *Lemke 669* (SWT); *Lyday 300* (SWT); *Staton 20* (SWT). Kendall Co.: *Breckenridge 573* (SWT). Travis Co.: *Carr 6165* (SWT). Val Verde Co.: *Labus 299, 323* (SWT).

Tridens texanus (S. Watson) Nash
Texas. Bandera/Medina Co.: *Lackey 486, 531* (SWT). Burnet Co.: *Lemke 2032* (SWT). Edwards Co.: *Evans 49* (SWT). Hays Co.: *Thomas 75* (SWT). Kimble Co.: *Sanchez 1033* (SWT). Llano Co.: *Breckenridge 562* (SWT); *Gould 7530* (TAES). Medina Co.: *Campos 24* (TAES). Val Verde Co.: *Labus 214* (SWT). Zavala Co.: *Casey 72* (SWT).

Triplasis purpurea (Walt.) Chapm.
Texas. Anderson Co.: *Hatch 5071* (SWT). Bailey Co.: *Gould 7745* (TEX-LL). Bastrop Co.: *Carr & Kutac 9264* (SWT). Cochran Co.: *Johnston & Walker 5431* (SWT). Crane Co.: *Warnock 15495* (SWT). Kerr Co.: *Cunningham 63-30* (TAES). Hutchinson Co.: *Higgins 9633* (TEX-LL). Limestone Co.: *Shinners 30571* (TEX-LL). Rusk Co.: *Rosen & Jones 671* (SWT). Tarrant Co.: *Fraser 64-2* (TAES). Travis Co.: *Higdon s.n.* (TEX-LL).

Tripogon spicatus (Nees) Ekman
Texas. Burnet Co.: Breckenridge *614* (SWT); *Lemke 2046* (SWT). Llano Co.: *Gould 7553, 9966* (TEX-LL); *Jones & Wipff 3343* (SWT); *Sestak 63* (TAES); *Tharp s.n.* (TEX-LL). Mason Co.: *Singhurst et al. 8206* (TEX-LL). Travis Co.: *Carr et al. 15096* (TEX-LL); *Carr & Turner 15842* (TEX-LL).

Tripsacum dactyloides (L.) L.
Texas. Bandera/Medina Co.: *Lackey 331* (SWT). Blanco Co.: *Sanchez 813* (SWT). Brazos Co.: *Rosen 276* (SWT). Fayette Co.: *Knight 171* (SWT). Gillespie Co.: *Allred 1454* (TAES); *Kast 20, 82* (TAES); *Sanchez 1022* (SWT). Hays Co.: *Breckenridge 587* (SWT). Medina Co.: *Gwaltney 30* (TAES). Uvalde Co.: *Kellner s.n.* (TAES); *Lemke 1805* (SWT). Washington Co.: *Toledo 35* (SWT).

Trisetum interruptum Buckley
Texas. Blanco Co.: *Wipff et al. 109* (TAES). Brazos Co.: *Hatch 2151* (TAES). Edwards Co.: *Evans 43* (SWT). Galveston Co.: *Waller & Bauml 3492* (SWT). Harris Co.: *Brown 20327* (TEX-LL). Kerr Co.: *May 5541* (TAES). San Augustine Co.: *George & Nixon 211* (TAES). San Patricio Co.: *Aljoe 21* (SWT). Washington Co.: *Jones & Wipff 1183* (SWT); *Toledo 34* (SWT).

Triticum aestivum L.
Texas. Bexar Co.: *Hagenbuch 30* (SWT). Brewster Co.: *Morden 433* (TAES). Dallas Co.: *Hynes s.n.* (TEX-LL); *Lundell & Lundell 12837* (TEX-LL). Galveston Co.: *Waller & Campbell 2692* (TEX-LL). Garza Co.: *Hutchins 465* (TEX-LL). Hays Co.: *Ruiseco 128* (SWT). Karnes Co.: *Lemke 1696* (SWT). Live Oak Co.: *S.&G. Jones 821* (TAES). Williamson Co.: *Swofford 100* (SWT).

Urochloa ciliatissima (Buckley) R.D. Webster
Texas. Bexar Co.: *Silveus 125* (TEX-LL). Caldwell Co.: *Johnston 6756* (SWT). Gillespie Co.: *Nixon 131* (TEX-LL). Hidalgo Co.: *Johnston 54536* (TEX-LL). Lavaca Co.: *Johnston 6746* (SWT). Leon Co.: *Johnston 6703* (SWT). Llano Co.: *Butterwick & Lamb 2931* (TEX-LL). Medina Co.: *Johnston et al. 3410* (TEX-LL). Travis Co.: *Carr & Price 11410* (TEX-LL). Williamson Co.:*Orzell & Bridges 10576* (TEX-LL).

Urochloa fusca (Sw.) B.F. Hansen & Wunderlin
Texas. Bastrop Co.: *Carr 6073* (SWT). Bexar Co.: *Carr & Turner 14010* (TEX-LL). Brazoria Co.: *Rosen 213* (SWT). Dimmit Co.: *S.&G. Jones 1712* (SWT). Fayette Co.: *Carr & Kutac 7850* (TEX-LL). Kleberg Co.: *Carr 11418* (TEX-LL). McLennan Co.: *S.&G. Jones 3218* (SWT). Nueces Co.: *Carr 11518* (TEX-LL). Travis Co.: *Gould 7621* (TEX-LL); *Turner 64* (TEX-LL).

Urochloa texana (Buckley) R.D. Webster
Texas. Brooks Co.: *Davis s.n.* (TEX-LL). Burnet Co.: *Wooton 65* (SWT). Duval Co.: *Correll & Johnston 25515* (TEX-LL); *Hatch 5266* (SWT). Eastland Co.: *Hill & McCart 9246* (TEX-LL). Garza Co.: *Hutchins 1369* (TEX-LL). Grayson Co.: *Nee 44003* (TEX-LL). Robertson Co.: *Lemke 3368* (SWT). Travis Co.: *Carr & Turner 15829* (TEX-LL). Webb Co.: *Baird 61-60-24* (TEX-LL).

Vulpia octoflora (Walt.) Rydb.
Texas. Aransas Co.: *Lemke 1417* (SWT). Brazos Co.: *Knight 150* (SWT); *Toledo 20* (SWT). Comal Co.: *Rakestraw 39* (TAES). Galveston Co.: *Rosen 559* (SWT). Grimes Co.: *Lemke 213, 227* (SWT). Kerr Co.: *Cocke 9* (TAES). Kimble Co.: *Morden et al. 699* (TAES). Leon Co.: *Couch 42* (SWT), *Snider 26* (TAES). San Patricio Co.: *Lyons 25* (SWT). Travis Co.: *Lemke 3511* (SWT).

Zizaniopsis miliacea (Michx.) Döll & Asch.
Texas. Bexar Co.: *Döll & Aschers 2249, 2676* (TEX-LL). Brazos Co.: *Stewart s.n.* (TAES). Chambers Co.: *Rosen 538* (SWT); *Whitbeck 58* (TAES). Hays Co.: *Tharp s.n.* (SWT). Llano Co.: *Rodgers et al. 6887* (TEX-LL). San Patricio Co.: *Toledo 44* (SWT). Travis Co.: *Barkley 13464* (TEX-LL); *Carr & Turner 15285* (TEX-LL). Trinity Co.: *Marsh & McLeod s.n.* (TAES). Walker Co.: *S.&G. Jones 640* (TAES).

Reid, C., D.J. Rosen, R. Carter, and P.M. Peterson. 2015. *Eragrostis plana* (Poaceae) new to Texas. Phytoneuron 2015-5: 1–3.
Published 1 February 2015. ISSN 2153 733X

ERAGROSTIS PLANA (POACEAE) NEW TO TEXAS

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ABSTRACT

Eragrostis plana (South African love grass) is reported new to Texas, where it was found on a coastal prairie remnant on the east side of the Houston metroplex. This species is native to southern Africa.

Eragrostis plana Nees, a native of southern Africa (Clayton 1974; Gibbs Russell et al. 1990; Peterson 2003), was initially reported as introduced in North America from South Carolina by Gould and Lonard (1970), who cited specimens collected near the Santee wool combing mill in Berkeley County, South Carolina. Many exotic weeds have been found near wool combing mills because seeds are easily transported from their source in the wool (McCormick 2005). *Eragrostis plana* was also reported from around sheep and cattle lots in Florence County, South Carolina (Peterson 2003) and it has been introduced in Brazil, where it is a troublesome weed of pasture, rangeland, and roadsides (Boechat & Longhi-Wagner 2001; Zenni & Ziller 2011).

In July of 2012 we collected *Eragrostis plana* (Fig. 1) from Deer Park Prairie, a coastal prairie remnant in southeastern Texas on the east side of the Houston metroplex. The plants were collected from the lower edge of a pimple mound — pimple mounds are small soil mounds, possibly of aeolian origin (Seifert et al. 2009), that are characteristic features of coastal prairies having Alfisol soils. The abundance of the weedy *Gaura longiflora* on many pimple mounds on the site may indicate past mechanical disturbance. Disturbance could have resulted from scraping by hay mowing equipment (Butler 1979), congregation of cows (C. Reid, personal observation), or some other source. Our visit to Deer Park Prairie was brief and we did not recognize *E. plana* at the time of collection. It appeared to be infrequent, but we did not carefully determine its abundance and distribution on the site. How *E. plana* was distributed to Deer Park Prairie is not known and is open to conjecture. Our collections represent the first for this species in Texas (Correll & Johnston 1970; Hatch et al. 1990; Jones et al. 1997; Turner et al. 2003; NatureServe 2014; USDA, NRCS 2014).

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POACEAE
U.S.A., TEXAS
Harris County
Eragrostis plana Nees
Small (ca. 50-acre) coastal prairie remnant in the town of Deer Park, about .5 km NE of the intersection of Spencer Hwy. and Luella Ave. Infrequent in very rich native plant community dominated by Paspalum plicatulum, Schizachyrium scoparium, Muhlenbergia capillaris, and Spartina spartinae.
GPS - N29° 40' 12.8", W95° 06' 33.4" (WGS 84)
D.J. Rosen 5763
R. Carter, C. Reid
27 July, 2012
UNITED STATES
3653869
NATIONAL HERBARIUM
01186764

Figure 1. *Eragrostis plana* collected from Deer Park Prairie in southeastern Texas in July 2012.

Voucher specimens: **USA. Texas**. Harris Co.: Small (ca. 50-acre) coastal prairie remnant in the town of Deer Park, about 0.5 km NE of the intersection of Spencer Hwy and Luella Ave., 29.671156 N, -95.108034 W, infrequent in a very rich native plant community dominated by *Paspalum plicatulum*, *Schizachyrium scoparium*, *Muhlenbergia capillaris*, and *Sporobolus spartinus* [=*Spartina spartinae*], 27 Jul 2012, *D.J. Rosen 5763 with Carter and Reid* (BRIT, TEX, US), *C. Reid 8143 with Carter and Rosen* (LSU).

ACKNOWLEDGEMENT

We thank Flo Hannah with Houston Audubon Society for arranging access to Deer Park Prairie.

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 11. EUDICOTS: BRASSICACEAE AND BURSERACEAE

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ABSTRACT

A floristic account is provided for the mustard and frankincense families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the Sonoran Desert of southwestern Arizona. The mustard family in the flora area includes 23 genera and 32 species; the majority are cool-season annuals (ephemerals). There are no hot-season annuals. *Lyrocarpa coulteri* and *Hesperidanthus* are the only mustards in the flora area growing during the warmer seasons. Among the 12 non-native species only 3 are established as reproducing populations in the flora area. Five species are represented in the fossil record. *Sibara angelorum* in Cabeza Prieta NWR is the only record for the United States. The frankincense family includes a single species (*Bursera microphylla*) in the flora area as well as in southwestern USA. This is the eleventh contribution for this flora published in Phytoneuron and also posted open-access on the website of the University of Arizona Herbarium (ARIZ).

This contribution to the vascular plant flora in southwestern Arizona is the eleventh published in a series in Phytoneuron and also posted open-access on the website of the University of Arizona Herbarium (ARIZ). The area of coverage is that of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta NWR, and the Tinajas Altas Region in the heart of the Sonoran Desert (Figure 1). Two eudicot families are included in this contribution: Brassicaceae and Burseraceae.

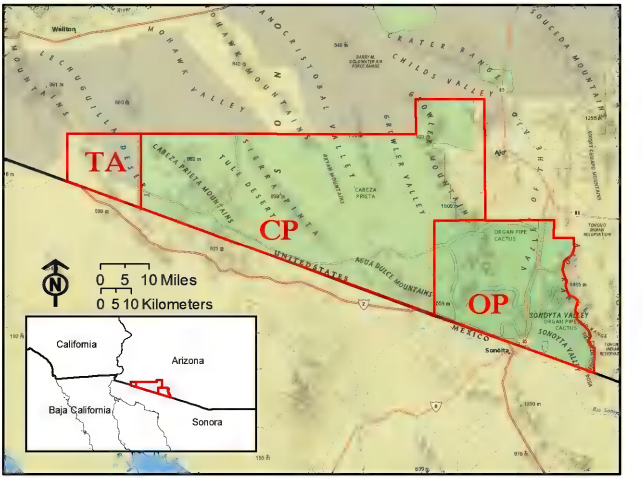

Figure 1. Flora area in southwestern Arizona. TA = Tinajas Altas. CP = Cabeza Prieta NWR. OP = Organ Pipe Cactus NM. Green shading indicates approximate boundaries of federally designated wilderness.

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens.

Fossil specimens are indicated with a dagger symbol (†) and the one fossil taxon no longer present in the flora area (*Athysanus pusillus*) is marked with two dagger symbols (††). Non-native species are marked with an asterisk (*) and non-natives not established (not reproducing) in the flora area are marked with double asterisks (**). In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish, and the Hia-Ced O'odham dialect, respectively (see Felger 2007 and Felger et al. 1992 for usage of Hia-Ced O'odham plant names). Spanish-language names are italicized. The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that such quantitative values are, to varying degrees, seldom exact. The identification keys are for the modern flora.

All photos and scans are by Sue Rutman unless otherwise stated. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2013). We have seen specimens or images of all specimens cited. When no collection number is provided, the

specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, and TA = Tinajas Altas Region. Additional explanation of the format for this flora series is provided in part 3 (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

BRASSICACEAE (CRUCIFERAE) – Mustard Family

Annual (ephemeral) and perennial herbs; containing mustard oils. Leaves alternate, the lower leaves often in a basal rosette; without stipules. Sepals and petals in a cross-like pattern—hence the alternate family name Cruciferae. Calyx cylindrical with 4 separate, mostly deciduous sepals. Petals 4 (or fewer or rarely absent), separate, mostly clawed (conspicuously narrowed basally). Stamens 6 (or sometimes fewer), usually with 2 outer, shorter stamens, and 4 inner ones of 2 opposite pairs. Ovary superior. Fruits (siliques or silicles) highly variable, dry, mostly 2-chambered capsules, dehiscent by 2 valves opening from base to apex, or sometimes 1-chambered and indehiscent, or separating into 1-seeded segments. Seeds often mucilaginous when wet. The family is easily recognized but the genera are often distinguished on technical characters of the fruit that can be difficult for the non-specialist to differentiate.

Crucifers recorded from the general flora area include 23 genera with 32 species (Table 1). Among the 32 species, 28 are cool-season ephemerals including 9 species not established as reproducing populations; non-natives include 12 species, and 9 of them are not established as reproducing populations in the flora area. Five or six species have been found in fossil packrat middens, one of which, *Athysanus pusillus*, is no longer present in the flora area.

Table 1. Local distributions of Brassicaceae and Burseraceae taxa. † = Taxa represented by a fossil specimen(s); †† = fossil taxon no longer present in the flora area; * = non-native taxa; ** = non-native taxa not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = summer/warm-season ephemerals; WI = cool-season/winter-spring ephemerals; PR = perennials. Localities and growth forms in parentheses are ones that are rare or seldom found and apparently not reproducing, or known only from fossils, and not part of the modern flora; these are not counted in the totals.

Taxon	Region			Growth Form		
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Ephemerals		Perennials
				Summer	Winter	
BRASSICACEAE						
††*Athysanus pusillus*	(OP)				(WI)	
Boechera perennans	OP					PR
****Brassica kaber*	(OP)				(WI)	
****Brassica nigra*	(OP)				(WI)	
***Brassica tournefortii*	OP	CP	TA		WI	
****Capsella bursa-pastoris*		(CP)			(WI)	
†*Descurainia pinnata*	OP	CP	TA		WI	
****Descurainia sophia*	(OP)				(WI)	
Dimorphocarpa pinnatifida		CP	(TA)		WI	
Dithyrea californica		CP	TA		WI	
***Eruca vesicaria*	OP				WI	
Erysimum capitatum	OP				WI	
Hesperidanthus linearifolius	OP					PR
†*Lepidium lasiocarpum*	OP	CP	TA		WI	
Lepidium oblongum	OP				WI	
Lepidium thurberi	OP				WI	

†*Lepidium* sp./spp.	(OP)		(TA)		(WI)	
Lyrocarpa coulteri	OP	CP	TA			PR
***Matthiola longipetala*	(OP)				(WI)	
***Nasturtium officinale*	(OP)					(PR)
Physaria tenella	OP	CP	TA		WI	
Planodes virginicum		CP			WI	
Sibara angelorum		CP			WI	
***Sisymbrium altissimum*	(OP)				(WI)	
**Sisymbrium irio*	OP	CP			WI	
***Sisymbrium orientale*	(OP)	(CP)			(WI)	
Streptanthus carinatus	OP				WI	
Streptanthus lasiophyllus	OP	CP	TA		WI	
Streptanthus longirostris		CP			WI	
Thelypodium wrightii	OP				WI	
***Thlaspi arvense*	(OP)				(WI)	
†*Thysanocarpus curvipes*	OP	CP	(†TA)		WI	
†*Tomostima cuneifolia*	OP	CP	TA		WI	
TOTALS	17	14	8	0	19	3
BURSERACEAE						
†Bursera microphylla	OP	CP	TA			PR

Most Sonoran Desert mustards are winter-spring ephemerals and produce their first and usually largest leaves in a basal rosette; cauline leaves (stem leaves above the basal rosette) are often gradually reduced above. *Lyrocarpa* is the exception, being perennial without a basal rosette and flowering at any time of year with sufficient moisture. A few herbaceous perennials such as *Boechera* and *Hesperidanthus* extend only to the margins of the desert, but like most Sonoran Desert crucifers, they grow and flower during the cooler seasons. *Hesperidanthus* also flowers after summer rains in August and September. (*Stanleya pinnata* in the Kofa Mountains, north of the flora area, is one of the few other perennial members of the mustard family that extend into the Sonoran Desert. It is, however, summer-dormant in the desert and only reaches the margin of the desert.) *Lepidium thurberi* is often biennial, but where it ranges into the desert it is an ephemeral.

The young plants of more than a dozen local species are potentially edible as greens, and the seeds are likewise potentially edible (Felger 2007; Hodgson 2001; Uphof 1968). The most economically important crucifers are in the genus *Brassica*; others include horseradish, radish, watercress, and ornamental garden flowers such as stock and wallflower. The family is worldwide with 321 genera and 3660 species (Al-Shehbaz 2010, 2012).

1. Fruits less than 2 (3) times longer than wide, variously shaped.

2. Plants with stellate hairs; petals yellow; fruits globose, bladder-like…….. **Physaria**
2. Plants with dendritic (branched) or simple hairs; petals white, or brownish to dull purple; fruits variously shaped, compressed (flattened).

3. Fruits spectacle-shaped (of 2 disc-shaped halves) joined by about 25% of their margins; flowers very fragrant; dunes and sand soils.

4. Leaves with slender lobes; petals (fresh) 5–7 mm long; fruiting pedicels 7–22 mm long; stigma triangular…….. **Dimorphocarpa**
4. Leaves with broad, coarse teeth or lobes; petals (fresh) 10–12 mm long; fruiting pedicels 1.5–2.5 mm long; stigma rounded…….. **Dithyrea**

3. Fruits not of 2 disc-shaped halves; flowers fragrant or not.

5. Perennials (sometimes flowering in first season), with dendritic hairs; petals 12–20+ mm long; fruits 10–28 mm long…….. **Lyrocarpa**
5. Winter-spring ephemerals, glabrous or with simple hairs; petals to 3 mm long or absent; fruits to 7.5 mm long.

6. Pedicels somewhat thick, straight to slightly curved; fruits 3–4 mm long, 2–seeded, not winged or inconspicuously winged at apex…… **Lepidium**
6. Pedicels slender, recurved; fruits 5.5–7.5 mm long, 1–seeded, the margin conspicuously winged and often with small perforations (holes)…….. **Thysanocarpus**

1. Fruits more than 3 times longer than wide, linear or narrowly oblong.

7. Plants glabrous or with simple hairs.

8. Fruit flattened; seeds winged or not.

9. Leaves pectinate, the segments linear; petals pale lavender to purplish; seeds wingless. ……..**Sibara**
9. Leaves entire to dentate, pinnatifid or pinnatisect; petals purple, white (sometimes tinged maroon or with purple veins); seeds winged.

10. Stem (cauline) leaves clasping; petals 14–18 mm long; fruits 4–6 mm wide…….. **Streptanthus carinatus**
10. Stem leaves not clasping—sessile or petiolate; petals less than 10 mm long; fruits less than 2 mm wide.

11. Leaves pinnatifid to pinnatisect; petals whitish; fruit 1–1.5 mm wide, not beaked…… **Planodes**
11. Leaves entire, dentate to sinuate, or pinnatifid; petals white (sometimes tinged with maroon or with purple veins) or purple; fruit 4–6 mm wide or with an indehiscent beak-like tip 3–5 mm long…… **Streptanthus** (in part)

8. Fruit rounded in cross-section (terete); seeds not winged.

12. Fruits with a tapering beak usually 2 mm or more long…… **Brassica**
12. Fruits not beaked.

13. Fruits often turned downward at maturity or spreading to ascending; fruiting pedicels 0.5–3 mm long…… **Streptanthus lasiophyllus**
13. Fruits ascending or spreading; fruiting pedicels 4–20 mm long.

14. Petals yellowish; cauline leaves pinnately lobed or pinnatisect; widespread. …… **Sisymbrium**
14. Petals white to purplish; cauline leaves entire or pinnately lobed; Ajo and Diablo Mts.

15. Outer pair of sepals with a callus (thickening) near the tip of each sepal; petals purple to pinkish or rarely white; stigmas 2-lobed; fruits not constricted between the seeds…….. **Hesperidanthus**

5. Outer pair of sepals without a callus; petals white or rarely purplish; stigmas entire; fruits constricted between seeds…..…**Thelypodium**

7. Plants with branched hairs (T-shaped, Y-shaped, or dendritic).

16. Plants with T-shaped (2-armed) hairs; Ajo Mts……..…….. **Erysimum**
16. Plants with dendritic hairs.

17. Leaves finely divided; petals yellow to pale yellow…….. **Descurainia**
17. Leaves entire to toothed (dentate); petals white or pink to purple.

18. Ephemerals; leaves all basal, l; fruits to 1.2 cm long; widespread…… **Tomostima**
18. Ephemerals and perennials; leaves not all basal; fruits 4 or more cm long; in the Ajo Mts or rare.

19. Perennials; petals 5–9 mm long; fruits 4–7 cm long; Ajo Mts……..…. **Boechera**
19. Annuals; petals 15 or more mm long; fruits 5–7 cm long; lowlands, scarce and probably not established……..…... **Matthiola**

Athysanus

Two species in western North America including northwestern Mexico.

††**Athysanus pusillus** (Hooker) Greene
[*Thysanocarpus pusillus* Hooker]
Common sandweed

Slender and delicate, cool-season ephemerals. Flowers rather inconspicuous with small white petals or often without petals. Fruits flat, rounded in outline, and 1-seeded.

It was in the Ajo Mountains more than 13,500 years ago. The nearest present-day populations are in the Kofa Mountains and near Tucson. In Arizona mostly at elevations above the desert. Western North America from British Columbia to Baja California and central Arizona.

OP: †Montezuma's Head, fruits, 13,500 ybp.

Boechera

Mostly perennial herbs; 110 species in North America including northern Mexico, and Russian Far East.

Boechera perennans (S. Watson) W.A. Weber
[*Arabis perennans* S. Watson]
Rockcress. Figure 2.

Perennial herbs, to 70 cm tall from a woody caudex. Stems usually 2–5 per caudex branch, densely pubescent proximally with Y-shaped and often 3–5-branched (dendritic) or rarely simple hairs, usually glabrous distally. Basal leaves oblanceolate to obovate, the margins dentate, the blade surfaces densely pubescent with 3–6-branched hairs. Cauline leaves clasping the stem, the uppermost usually glabrous. Fruiting pedicels usually horizontal, 6–25 mm long. Petals whitish tinged with pink or purple, 5–9 mm long. Fruits widely pendent and usually curved, (3) 4–7 cm × 1.7–2.1 mm, glabrous; ovules 60–96 per ovary. Growing and flowering during the cooler seasons of the year.

Ajo Mountains, often among rocks, especially canyons and slopes at higher elevations. It does not extend into the lower desert.

Southwestern United States and northern Mexico in Baja California, Chihuahua, and northern Sonora.

OP: Alamo Canyon: 2500 ft, *Nichol 14 Mar 1939*. Canyon bottom at margin of wash, 29 Mar 2003, *Felger 03-421*. Arch Canyon trail, corolla blue-purple, 11 Mar 1983, *Daniel 2617* (ASU). Middle fork Alamo Canyon near crestline of Ajo Mts, 15 Mar 2003, *Rutman 2003-340* (ORPI).
Sonora: Banori, Altar Dist., 15 Feb 1938, *Gentry 3540*.

Figure 2. *Boechera perennans*. (A) Arch Canyon, 29 Feb 2009. (B) Woods Canyon, S of Sedona, Yavapai Co., 26 Feb 2005, photo by Max Licher (SEINet).

***Brassica** – Mustard; *mostaza*

Cool-season ephemerals with yellow flowers and slender, dehiscent fruits (those in the flora area). Molecular phylogenetic studies have revealed that the genus *Brassica* is not monophyletic and the generic boundary will need revising (Warwick & Sauder 2005).

Native to the Old World (*B. kaber* may be an exception), widely cultivated and introduced worldwide; includes cabbage, canola, cole, mustard, and turnip; 43 species.

1. Flowers pale yellow, the petals 6–8 mm long; fruits 3.5–7 cm long, widely spreading, the beak 10–20 mm long..... **Brassica tournefortii**
1. Flowers bright yellow, the petals usually 8 or more mm long; fruits less than 2.5 cm long, erect and appressed to the flowering stem (rachis), the beak 1–6 mm long.

2. Outer pair of sepals with a callus (thickening) near the tip; fruit valves each with 3–7 veins, the lateral veins conspicuous (need mature fruits)..... **Brassica kaber**
2. Outer pair of sepals without a callus; fruit valves each with 1 prominent midvein, the lateral veins inconspicuous..... **Brassica nigra**

****Brassica kaber** (de Candolle) L.C. Wheeler
[*Sinapis arvensis* Linnaeus; *S. kaber* de Candolle. Not *Brassica arvensis* Linnaeus; *B. arvensis* Rabenhorst is illegitimate]
Charlock. Figure 3.

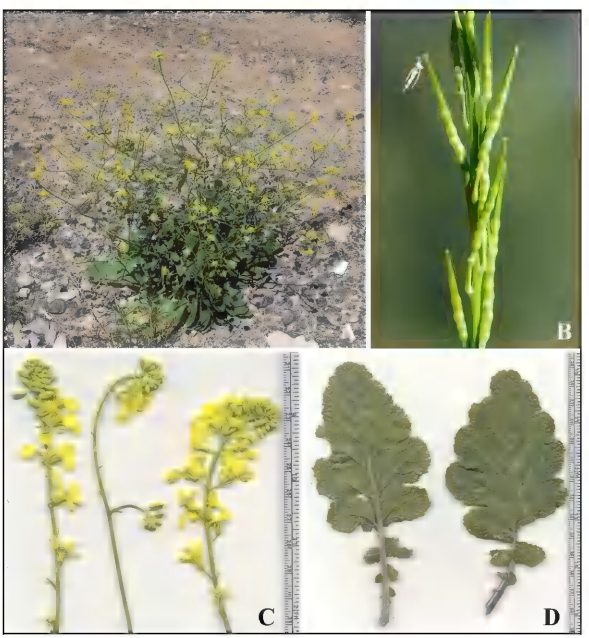

Figure 3. *Brassica kaber*. (A, C & D) Mex Hwy 2 at Los Vidrios, Sonora, 5 Mar 2014. (B) Merced River, Briceburg, Mariposa Co., CA, 21 Mar 2009, photo © by Barry Breckling (CalPhotos).

Cool-season ephemerals, 0.5–1.5+ m tall, the lower part of the plant often with coarse hairs (hispid). Basal leaves obovate, oblong, or lanceolate, (8.5) 25–50+ cm long, (3.5) 15–27 cm wide, and lyrate, pinnatifid or sometimes undivided; upper (cauline) leaves with coarsely toothed margins and often simple. Sepals, petals, stamens, and young ovary yellow, the petals uniformly bright yellow, 8–12 (17) mm long, the blade broadly obovate, the claw slender. Fruiting pedicels ascending, 3–7 mm long. Fruits linear, terete, 1.5–5.7 cm × 1.5–4.3 mm; ovules (4) 8–16 (24) per ovary.

Common farm weed and sometimes along roadsides near the flora area in southern Arizona and northwestern Sonora; not known from the flora area but occasional plants might be expected

along Highway 85. Native to the Mediterranean region, and non-native, weedy, and widespread in North America and elsewhere in the world. Also reported to be in the northeastern United States 8000 years ago, suggesting it originally had a semi-circumboreal distribution (Jacobson et al. 1988; Warwick 2010). *Brassica kaber* is easily confused with *B. nigra* and they are difficult to tell apart without mature fruits, or sometimes even with mature fruits.

Maricopa Co: 10–15 mi W of Gila Bend on I-8 and 0.8 mi E of Paloma Rd, roadside by agricultural fields, locally abundant weed to about 4 ft. high, 3 Mar 2001, *Salywon 980* (ASU).

Pinal Co: Junction of I-8 and Bianco Rd, ca. 5 mi SW of Casa Grande, roadside, 100% cover of *Brassica*, *Erodium cicutarium*, and other weedy ephemerals, 25 Feb 1993, *Felger 93-28* (ARIZ, ASU).

Yuma Co: Yuma mesa, *Vince Roth 30 June 1957* (det. *B. tournefortii* by C.T. Mason 1985; det. *S. arvensis* by Suzanne I. Warwick 1995).

****Brassica nigra*** (Linnaeus) W.D.J. Koch
[*Sinapis nigra* Linnaeus]
Black mustard; *mostaza negra*. Figure 4.

Figure 4. *Brassica nigra*. (A & B) Sedona, Yavapai Co., 2 May 2005, photos by Max Licher (SEINet). (C) Hercules, Contra Costa Co., CA, Jun 2009, photo © by Zoya Akulova (CalPhotos).

Plants sparsely pubescent with soft hairs or glabrate; reaching 50–100 cm tall, with spreading flowering branches. Basal rosette leaves 8–30 (50) cm long, the stem leaves reduced upwards; leaves variable, similar to those of *B. tournefortii* but usually greener and with broader lobes. Flowers bright yellow and showy. Sepals 10 mm long. Petals clawed, 15–24 × 7+ mm, the veins inconspicuous on fresh flowers, dark and conspicuous when dried. Fruiting racemes often 20–40 cm long. Fruits erect and appressed, 20–22 mm long, more or less 4-angled, the beak seedless, about ¾ as long as the body; fruiting pedicels 3–4.5+ mm long. Seeds globose, ca. 2 mm in diameter, not mucilaginous when wet.

Occasional in disturbed habitats including roadsides and parking lots; not established in the flora area. Usually blooming in April after most native ephemerals.

A worldwide weed, native to Eurasia, and also cultivated as a mustard condiment. Present in Arizona at least since 1884.

OP: Alamo Wash-Sonoyta road, 22 Apr 1941, *Supernaugh 6* (ORPI). Hwy 85, 2.5 mi S of Eagle Pass, 7 Apr 2003, *Rutman 2003-449*.

***Brassica tournefortii** Gouan
[*B. tournefortii* var. *dasycarpa* O.E. Schulz; *B. tournefortii* forma *dentata* O.E. Schulz; *B. tournefortii* var. *leiocarpa* Marie & Weiller; *B. tournefortii* var. *recurvata* Bornmüller; *B. tournefortii* var. *sisymbrioides* Fischer ex de Candolle]
Sahara mustard; *mostaza*. Figure 5.

Coarse ephemerals, with a well-developed taproot, highly variable in size, the plants as small as 15 cm tall when drought stressed, or sometimes reaching 1.2 m tall on dunes; stems simple to many-branched above. Lower part of plant densely hirsute with coarse, rough, white hairs, especially the lower leaf surfaces along the midrib, veins, and margins; glabrescent distally. When dry and dead these large plants break off at the root and may become tumbleweeds. Leaves of basal rosettes (8) 15–30 (80+) cm long, petioled, pinnatifid with the terminal lobe usually largest (lyrate-pinnatifid), or leaves of stunted plants often obovate and merely toothed; cauline (stem) leaves usually greatly reduced upwards.

Flowers selfing (autogamous). Sepals 3.5–4 mm long, pale, almost translucent, purple-brown, slightly swollen basally. Petals, stamens, and stigma pale yellow, often becoming whitish with age. Petals 4–8 mm long; corolla bilaterally symmetrical (unlike most other mustards, the petals are not at right angles to one another: two of the opposite angles are less than 90° and two are much more than 90°). Stamens at the same height as, and touching, the stigma (this contact between the stamens and the stigma occurs during flowering, indicating a self-pollinating reproductive strategy; e.g. Hinata et al. 1974 and Van Devender et al. 1997). Fruiting pedicels (6) 12–16 (22) mm, spreading to ascending. Fruits cylindric and torulose, 3–7 × 2–4 (5) cm, with a stout beak 11–20 mm long and 1 (2)-seeded. Seeds 1.3 mm in diameter, rounded, reddish brown, mucilaginous when wet. Seeds often germinate with fall rains, before the seeds of most native desert annuals germinate. When fully dry, the siliques can pop open with the touch of finger, and presumably when rattled by the wind. Many, however, just sit there on the plant, and need to roll around in the sand to open.

Widespread invasive weed in lowland disturbed and natural desert habitats across the flora area, especially on sandy soils and washes, but also on rocky slopes (Felger 1990). During favorable years it makes up a significant part of the plant cover on the dunes and sand hummocks of the Pinta Sands. The broad, spreading basal rosette leaves can effectively prevent the establishment of other cool-season ephemerals. Plants on sandy soils with sufficient soil moisture may grow to more than 1–1.5 meters across, making this species the largest herbaceous rosette plant in the region (Felger 2000: 186). Autogamy, together with the plasticity in plant size and early germination, undoubtedly contribute to the success of Sahara mustard in the Sonoran Desert and elsewhere.

On 28 March 2010, Richard Laugharn and Felger were in the miniature mesquite thicket in the Lechuguilla Valley where the Camino del Diablo crosses Coyote Wash and Felger made the following observations: "Much of the ground is now 100% covered by *Brassica tournefortii* of incredible size variation, but each local niche or micro-habitat of *Brassica* generally has plants of the same size—some very crowded stands consist of dwarfed plants, some reproducing with only a single fruit of 3–7 seeds, the lower stem leaves 1–several cm long, and basal rosette leaves often only 1–3 or sometimes not developing, the stems extremely slender and the plants 8.7–11.4 and more cm in height. Other, less crowded, robust plants have rosette leaves more than 30 cm long. Obviously

B. tournefortii is changing the cool-season species diversity in this habitat. The soil is still damp from the last rains and where the ground is not covered by ephemerals there is a continuous blackish surface of biological soil crust that includes cyanobacteria."

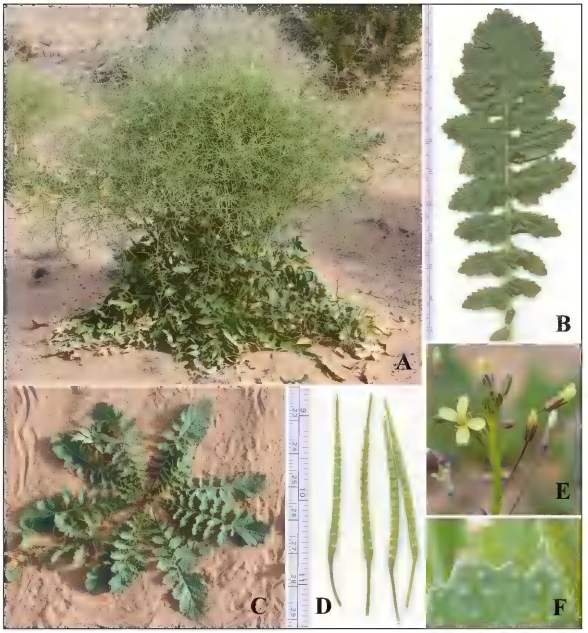

Figure 5. *Brassica tournefortii.* Dunes, 22 mi SW of Sonoyta on Mex Hwy 8, Sonora: (A) 3 Mar 2008; (C, E & F) 6 Feb 2014. (B & D) Alamo Wash, 29 Jan 2014.

Native to the Old World, probably North Africa and Central Asia, this species has become established in many warm, arid regions of the world. It has spread almost explosively across the Sonoran Desert, especially in sandy soil habitats. Sahara mustard is one of the most seriously invasive species in the flora region (Guertin 2003 provides an excellent summary of related information). Sahara mustard has also spread to Nevada, Utah, New Mexico, Texas, and northern

Mexico, as well other parts of the world such as Australia where it has become invasive. It was first reported from southeastern California by Jepson (1923–1924), apparently first collected in North America at Coachella in Riverside County in 1927, and established in agricultural areas in southeastern California by 1938. The earliest Arizona specimen is from 1955; Sahara mustard was collected in northwestern Sonora in 1966; and since at least the 1970s it has become widespread in the Sonoran Desert Region (Barrows et al. 2009; Dimmitt & Van Devender 2009; Felger 1990, 2000; Malusa et al. 2003; Van Devender et al. 1997).

Ihsan Al-Shehbaz (pers. com., 17 Dec 2014) wrote, "I do not divide *B. tournefortii* into infraspecific taxa based on density of indumentum, and I personally do not see sharp discontinuous differences in flower size." However, there are reports of infraspecific variation. For example, Zohary (1966: 309) reported that in the Middle East, "desert specimens are more densely hispid and have smaller flowers; they are probably to be classed as a separate subspecies." René Maire (1965) included 5 varieties and one forma in the Flora of North Africa, although currently considered as synonyms (e.g., Warwick 2010). Mark Dimmitt (pers. com. 2014) reported, "The original introduction of *B. tournefortii* near Mecca, California, is still present, and looks and behaves differently from other populations. It is a smaller, more gracile plant found only in disturbed soils where it is competing with numerous other exotic weeds. I did not see it in undisturbed desert in the Coachella Valley. The really invasive form is a later introduction with more aggressive traits." The USDA North Central Regional Plant Introduction Station in Ames, Iowa, has several accessions of this species for distribution as an experimental oilseed. However, Marushia (2009) found no differences between mesic and desert populations of *B. tournefortii*, but noted that the species has a more rapid phenology than its congeners (Marushia et al. 2010). Li and Malusa (2014) found that it has a germination rate (mean > 80%) in the field significantly higher than the native cool season annuals.

Minnich and Sanders (2000) report nearly 100% fruit set on most plants and that rain facilitates the production of a sticky gel (seeds become mucilaginous when wet) covering the seed capsule, permitting long distance dispersal of the seeds by adhesion to animals, and possibly vehicles. In Organ Pipe Cactus National Monument, Sue Rutman has observed entire cohorts of seedlings killed by freezing temperatures (also see Dhawan et al. 1982). However, the annual frequency of freezing temperatures in Organ Pipe (and elsewhere in the Sonoran Desert) has been decreasing since the 1980s (Weiss & Overpeck 2005), perhaps even further facilitating the success of Sahara mustard.

OP: Quitobaquito: 8 Feb 1978, *Bowers 1030*; 29 Mar 1988, *Felger 88-136*. Visitor Center, roadside, 16 Feb 1979, *Bowers 1566*. Cipriano Hills, 20 Mar 2003, *Rutman 2003-365* (ORPI).

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3952*. Papago Well, 26 Feb 1993, *Felger 93-418*. Pinta Sands, 11 Apr 1993, *Felger 93-418*.

TA: Tinajas Altas Mts, above the tinajas, 19 Mar 1998, *Felger* (observation). Camino del Diablo, E of Raven Butte, 29 Nov 2001, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-33*. Camino del Diablo at Coyote Wash, 28 Mar 2010, *Felger 10-172*. Surveyors Canyon, Lamb Tank, 29 Mar 2010, *Felger 10-197*. Canyon below Raven Butte Tank, 29 Mar 2010, *Felger 10-242*.

Yuma Co.: Near Palm Canyon, Kofa Mountains, 2400 ft, 21 April 1955, *Haskell 5058 & C.F. Deaver* (ASC 10855; det. Reed C. Rollins). Yuma Mesa, 1 mi E of Airbase, *Hamilton 26 March 1959* (ARIZ 130879; det. Andrew C. Sanders 2000).

California: Riverside Co.: Coachella, *J.B. Feudge 25 Feb 1927* (RSA 1660; det. Andrew C. Sanders).

***Capsella**

Native to Eurasia; 5 species.

****Capsella bursa-pastoris** (Linnaeus) Medikus
Shepherd's purse; *hierba del pastor*. Figure 6.

Cool-season ephemerals, to 50 cm tall, sparsely to densely pubescent with 3–5-rayed hairs. Flowers minute, white. Fruits obcordate, strongly compressed (flattened), 0.3–1 cm × 2–9 mm.

About one dozen plants sprang up from discarded hay at a temporary horse pen in the southwest corner of Cabeza Prieta but did not become established. The nearest record is in the Yuma region and it is a potential weed in gardens and agricultural fields.

Native to Eurasia and now a worldwide weed.

CP: Bajada of Tordillo Butte, 27 Feb 1993, *Felger 93-201*.
Yuma Co.: In soil accumulated before first Gray Tank in west branch, Township 2S, Range 19E, Section 34, 1760 ft, rare at wet tanks, *8 Dec 1985 Russo 246*.

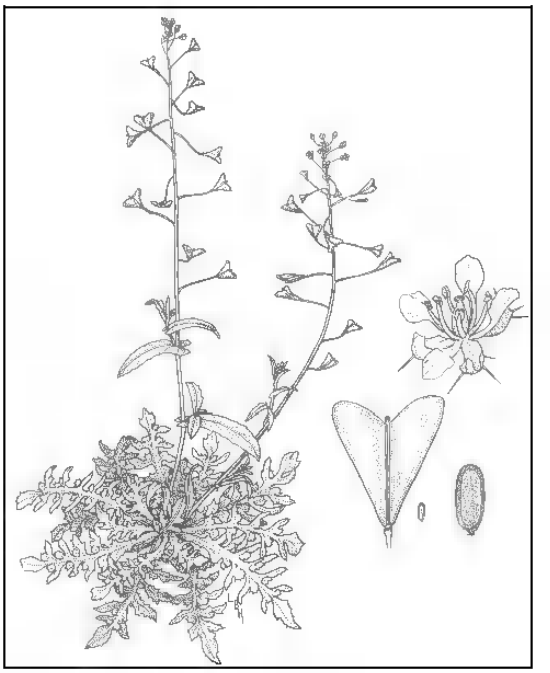

Figure 6. *Capsella bursa-pastoris*. By Lucretia Breazeale Hamilton.

Caulanthus, see **Streptanthus**

Descurainia – Tansy mustard
Americas, Eurasia, North Africa, and Canary Islands; 35 species.

1. Flowers pale yellow; fruits 3.5–7.2 mm long..... **Descurainia pinnata**
1. Flowers yellow; fruits 12–30 mm long..... **Descurainia sophia**

Descurainia pinnata (Walter) Britton
Western tansy mustard; *pamita*; su'uvad. Figure 7.

Cool-season ephemerals, 8–60 cm tall, mostly unbranched to few-branched above, with branched and candelabra-shaped, soft, white hairs. Stems leafy; early leaves usually in a basal rosette, these and larger stem leaves (1) 3–7 × (0.4) 2–3 cm, 1–3 times pinnatifid-divided, reduced

upwards, usually withering as the fruits develop. Fruiting pedicels usually ascending to horizontal, 4–18 (23) mm long. Inflorescences of racemes (3) 5–32 (45) cm long. Petals pale yellow, 1.5 mm long. Fruits (3.5) 4–7.2 × 1.2–1.6 mm, narrowly club-shaped; ovules 16–40 per ovary. Seeds reddish brown, 0.8 mm long, mucilaginous when wet.

Widespread across the flora area, sandy to rocky soils, washes, plains, bajadas, hills, and mountains. It was in the Butler Mountains more than 10,000 years ago.

Figure 7. *Descurainia pinnata*. By Lucretia Breazeale Hamilton.

Widespread in North America: Mexico to northern Canada. Four subspecies are sometimes recognized, two of which range into southwestern Arizona: subsp. *glabra* (Wooton & Standley) Detling, not canescent, and subsp. *ochroleuca* (Wooton) Detling, canescent.

The seeds were widely used for food (Bean & Saubel 1972; Felger et al. 1992; Rea 1997). Castetter and Underhill (1935: 24) say that it was "the most common [wild] seed crop" of the Tohono O'odham. Young plants were sometimes boiled as greens or pit-baked by the Quechans (Castetter & Bell 1951). Substantial quantities of the seeds have been found in Hohokam sites, which led Bohrer (1986 in Hodgson 2001) to speculate that it was cultivated. It can be a common weed in cultivated fields, which may have been a source for the Hohokam. The seeds, which become mucilaginous when wet, were widely esteemed for medicinal purposes (Bean & Saubel 1972; Hodgson 2001). Among the Hia C-ed O'odham the "seeds [were] used as food and eye medicine (Delores Lewis) or put in water and drunk for stomach trouble (Philip Salcido)" (Felger et al. 1992: 22–23).

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Quitobaquito, 14 Apr 1963, *Felger 7655*. Near Gachado Line Camp, 28 Jan 1978, *Bowers 1013* (ORPI).

CP: Buckhorn Tank, 27 Feb 1993, *Felger 93-184* (CAB). O'Neill Hills, 12 Mar 1993, *Harlan 359*. Tule Tank drainage, 23 Mar 1993, *Harlan 133* (CAB). Childs Mt, 9 Apr 1993, *Felger 93-277*.

TA: Frontera Canyon, 18 Mar 1998, *Felger* (observation). Coyote Water, 21 Feb 2005, *Felger 05-152*. †Butler Mts, fruit, 10,360 ybp.

****Descurainia sophia*** (Linnaeus) Webb ex Prantl

Figure 8.

Stems upright, single or branched above. Leaves often 3-times dissected into slender lobes. Fruiting pedicels 5–20 mm long. Flowers yellow, the fruits slender, often 12–25 mm long.

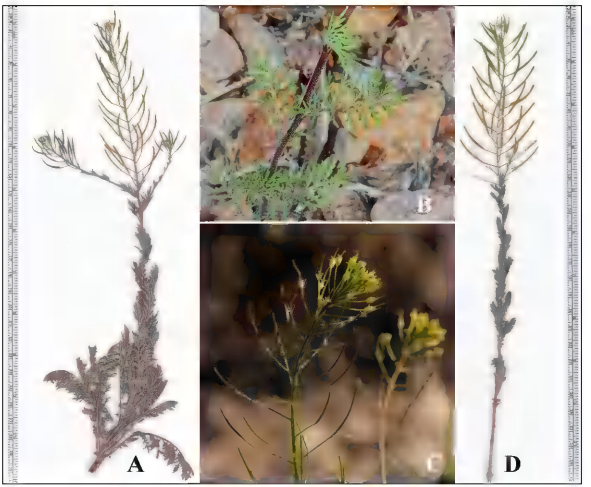

Figure 8. *Descurainia sophia*. (A & D) Construction site, Hwy 85 at 2 mi S of N boundary of Organ Pipe, 12 May 2010. (B) Silver City, Grant Co., NM, 29 Mar 2009, photo by Russell Kleinman (gilaflora.com). (C) Valley of Fires Recreation Area, Lincoln Co., NM, 2 Apr 2007, photo by Patrick Alexander.

Found at a construction site along Highway 85 in Organ Pipe and not established in the floral area.

Widespread weed in North America and elsewhere; native to Eurasia.

OP: Road shoulder of State Route 85, northern 3 mi of highway in Organ Pipe (between milepost 58 and 61), *Rutman 4 Jun 2010*.

Dimorphocarpa – Spectacle-pod

Southwestern United States and northern Mexico; 4 species.

Dimorphocarpa pinnatifida Rollins
[*Dithyrea wislizeni* Engelmann, in part]
Dune spectacle-pod. Figure 9.

Cool-season ephemerals, erect to ascending, sometimes sprawling to more than 1 m across, gray-green with stellate and candelabra-shaped hairs. Stems leafy. Leaves petioled below, sessile above, linear to narrowly lanceolate, pinnatifid with widely spaced slender lobes, larger leaves (3.5) 4–18 × 0.7–2.6 cm. Flowers on racemes 9–38 cm long. Fruiting pedicels spreading to slightly reflexed, 7–22 mm long. Flowers fragrant, attracting butterflies, the petals 5–7 mm long, pure white, the stigma and anthers yellow (corollas thus appear to have a yellow throat). Fruits of 2 disc-shaped indehiscent segments, each 5.5–8.2 mm wide and 1-seeded, the fruits turned at an angle to the pedicel. Seeds disc-like, 2–3.5 mm in diameter. The flowers are smaller and the plants often much larger than those of *Dithyrea californica*, the other spectacle-pod in the region. $x = 9$

Figure 9. *Dimorphocarpa pinnatifida*. (A) Dunes, 22 mi SW of Sonoyta, Sonora, 6 Feb 2014. (B) By Matilda Essig. Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora: (C & D) 15 Feb 2010; (E) 23 Feb 2010.

Pinta Sands and Mohawk Dunes, and more widespread on dunes in nearby northwestern Sonora. One plant seen at higher elevation in the Tinajas Altas Mountains and apparently not reproducing.

Endemic to dunes and adjacent sands in Yuma County, including the Mohawk Dunes, and the Gran Desierto of northwestern Sonora (Felger 2000; Felger et al. 2003). Related to, and narrowly allopatric from, the widespread *D. wislizeni* (Engelmann) Rollins in AZ, CO, NM, NV, UT, Chihuahua, and Coahuila. *Dimorphocarpa pinnatifida* can be distinguished from *D. wislizeni* by having upper stem leaves pinnately lobed and fruit valves orbicular and rounded apically.

CP: Pinacate Lava Fields, 20 Mar 1933, *Shreve 6218*. E edge of Pinacate Lava Flow, 17 Apr 1983, *Hodgson H 2081* (DES). 6.6 mi W of O'Neill's Grave, 18 Feb 1979, *Phillips 79-53* (ASU). Pinta Sands: 18 Feb 1979, *McLaughlin 1947*; 1 Feb 1992, *Felger 92-27*.

TA: Tinajas Altas, canyon bottom above uppermost tinaja, one large plant seen, no fruit setting, 19 Mar 1998, *Felger 98-138*.

Dithyrea – Spectacle-pod

Southwestern United States and northwestern Mexico; 2 species.

Dithyrea californica Harvey

[*D. californica* var. *clinata* (Macbride & Payson) Wiggins; *D. clinata* Macbride & Payson]

California spectacle-pod. Figure 10.

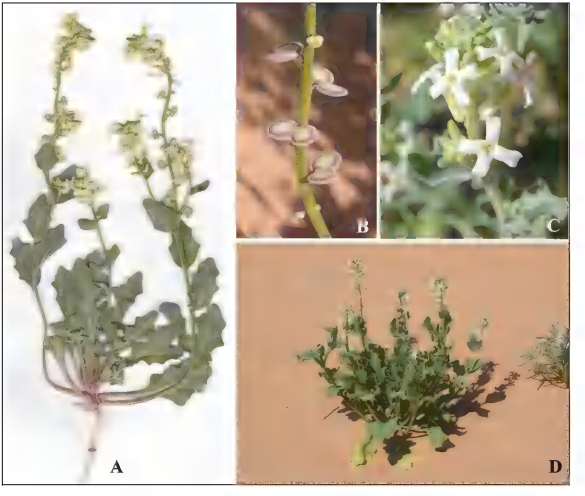

Figure 10. *Dithyrea californica*. (A, B & D) Dunes, 20 mi SW of Sonoyta, Sonora, 27 Mar 2010. (C) Dunes S of Sierra Blanca, Sonora, 15 Feb 2014.

Cool-season ephemerals. Stems 15–50 cm tall, mostly branching from the base. Herbage with slender-rayed, candelabra-shaped white hairs. Leaves semi-succulent when young, basal rosette and lower leaves with large, broad, coarse teeth or lobes, 4.5–15.5 cm long, petioled, more or less oblanceolate to oblong, the upper leaves sessile, ovate to broadly oblong. Fruiting pedicels 1.5–2.5 mm long. Flowers highly fragrant, the petals 10–12 mm long, cream-white, strap-shaped, partially recurved, twisted, and crenulate (wavy). Fruits spectacle-shaped, of 2 halves (valves), each half 4.5–6.5 mm wide, indehiscent, orbicular to slightly wider than long, strongly flattened, and 1-seeded, with simple, thickened (sac-like or vesicular) hairs especially dense on the cord-like margin. Seeds 3–4 × 1.5–2.5 mm.

Sand flats and dunes, and sand soils in the Pinacate Lava in the southern part of Cabeza Prieta, especially the Pinta Sands.

Sonoran and Mojave Deserts in northwestern Sonora, western Arizona, southeastern California, southern Nevada, and both Baja California states. Distinguished in part from *Dimorphocarpa* (the other spectacle pod) by having a chromosome number based on $x = 10$, coarser leaf lobes, stouter and shorter pedicels, and larger flowers.

CP: Pinacate Plateau, *Goodding 29 Nov1938*. Monument 182, *Monson* 7 Feb 1958. W edge of sands W of Pinacate Lava, 17 Jan 1964, *Simmons 12*. Pinta Sands: 10 Apr 1978, *Reeves 6793* (ASU); 1 Feb 1992, *Felger 92-28*. San Cristobal Valley, 11 Mar 1998, *Anderson 98-36* (ASU).
TA: Butler Mts, *Van Devender 27 Mar 1983*.

Draba cuneifolia, see **Tomostima cuneifolia**

***Eruca**

This genus has a single species.

***Eruca vesicaria** (Linnaeus) Cavanilles subsp. **sativa** (Miller) Thellung
[*E. sativa* Miller; *Brassica eruca* Linnaeus]
Garden rocket, salad rocket, arugula. Figure 11.

Cool-season ephemerals (15) 50–70+ cm tall, with simple white hairs. Early leaves in a basal rosette, 6–20+ × 3–10+ cm, pinnately lobed. Flowers on erect stalks, the petals to 17 mm long, pale yellow often fading to white, and with purple veins, narrowed at base (clawed). Fruiting pedicels 4.5–6.7 mm long, erect; fruits terete and rather stout, longer than wide, erect, and dehiscent; fruit body 17–20 (40) × 2.5–5 mm, with a prominent flattened, seedless beak 6–7 mm long. Seeds pale or grayish brown, mucilaginous when wet.

Common in areas to the north and south of flora area and found as occasional waifs in Organ Pipe where it is likely to spread.

Widely naturalized in southwestern Arizona, mostly but not exclusively near roads; especially abundant during El Niño years when it can blanket the desert along I–8 and adjacent areas from Gila Bend to Wellton. It is likewise common during wet winters in the Sonoyta and San Luis regions of northwestern Sonora. However, in 2014 it was still not established at Ajo.

Native to the Mediterranean region, now widespread and weedy from Canada to southern Mexico and many regions worldwide. It has been in Arizona since at least the early 20th century. Cultivated arugula is a popular salad green and has been cultivated since ancient times, including by the Greeks and Romans. The seed oil is used for cooking, as animal food, as an industrial lubricant, and for cosmetics and medicinal purposes (Al-Shehbaz 1985; Warwick 2010).

Figure 11. *Eruca vesicaria* ssp. *sativa*. Gila Bend, Maricopa Co.: (A) 4 Apr 2002; (B, C & E) Mar 2005. (D) Cinder hills, Sentinel Plain, Maricopa Co., 17 Jan 2005.

OP: Bates Well Rd, 1 mi S of N boundary of Monument, UTM 319371, 3562940, 1493 ft, two plants occurred on the berm of the road, in disturbed soil, *Conner 16 Feb 2005*.

Erysimum – Wallflower

North America to Central America, Eurasia, North Africa, and Atlantic islands; 200 species.

Erysimum capitatum (Douglas ex Hooker) Greene
[*E. capitatum* var. *purshii* (Durand) Rollins]
Western wallflower. Figure 12.

Cool-season ephemerals, or perhaps short-lived perennials, usually tall and slender. Leaves linear to oblanceolate, 2–18+ cm long, with 2–4 (7)-rayed hairs, the margins entire or toothed. Fruiting pedicels spreading to ascending, narrower than the fruit, 4–17 (25) mm long. Flowers

showy, the petals yellow, 15–25 mm long. Fruits 4–10 cm long, 1–2 mm wide, 4-angled to slightly flattened; ovules (40) 50–82 per ovary.

Figure 12. *Erysimum capitatum*. (A) Wilson Canyon, N of Sedona, Coconino Co., 3 Mar 2004, photo by Max Licher (SEINet). (B) Pancho Canyon, Burro Mts, Grant Co., NM, 7 Nov 2008, photo by Russell Kleinman (gilaflora.com). (C) Bluff Spring, Sacramento Mountains, Otero Co., NM, 16 Jun 2007, photo by Patrick Alexander. (D) Seeds and silique, Pinos Altos, Grant Co., NM, 8 Feb 2009, photo by Russell Kleinman (gilaflora.com).

Known in flora area from a single record in the Ajo Mountains. The specimen has T-shaped (2-armed) hairs on the leaves, aligning it with var. *purshii*, although the varieties are probably not worthy of recognition.

A morphologically diverse and widespread species in non-desert regions of Arizona and generally absent from the Sonoran Desert. North America from Alaska to central Mexico.

OP: Alamo Canyon, *Tinkham 15 Apr 1942*.

Hesperidanthus

Perennials or subshrubs. Western United States and northern Mexico; 5 species.

Hesperidanthus linearifolius (A. Gray) Rydberg
[*Schoenocrambe linearifolia* (A. Gray) Rollins; *Sisymbrium linearifolium* (A. Gray) Payson; *Thelypodiopsis linearifolia* (A. Gray) Al-Shehbaz]
Purple rock-mustard. Figure 13.

Glabrous, erect perennials to more than 2 m tall from a caudex. The stem leaves linear to lanceolate, 2.5–10 (15) cm long, entire or nearly so and relatively thick. Petals purple, with age becoming white, 12–16+ mm long. Flowering February to May and after summer rains in August and September. Fruiting pedicels spreading to ascending, 5–25 mm long. Fruits 4–10 cm long, 1–1.5 mm wide, terete, not constricted between seeds; ovules 76–110 per ovary.

Figure 13. *Hesperidanthus linearifolius*. Estes Canyon, Bull Pasture Trail: (A) 7 Mar 2014; (B) 27 Feb 2014. (C) Allie Canyon near Mimbres, Pinos Altos Mts, NM, 8 Sep 2010, photo by Russell Kleinman (gilaflora.com).

Widespread in the Ajo Mountains above 730 m and higher elevations in the Puerto Blanco Mountains.

Arizona and Sonora at elevations generally above the desert, to Colorado, Texas, and northern mainland Mexico to San Luis Potosí, Durango, and Zacatecas.

OP: Alamo Canyon, *Nichol 4 May 1939*. Arch Canyon, 28 Mar 1965, *Niles 539*. Grass Canyon, 26 Feb 1978, *Bowers 1090*. Rare in shady spots on upper slopes of Puerto Blanco Mts, NW of Pinkley Peak, 2500 ft, *Rutman 24 Mar 2001* (ORPI). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-274*.

Lepidium – Peppergrass, pepperwort, cress, peppercress; *lentejilla*

Cool-season ephemerals, glabrous or with simple hairs. Flowers small, with white petals, these often reduced or the petals might be absent and the flowers selfing (autogamous). Fruits small and disc-shaped. Seeds highly mucilaginous when wet.

The herbage, flowers and fruits have a sharp, pepper- or chili-like flavor and can be used as a condiment. Nearly worldwide; 250 species.

1. Pedicels terete and slender; petals 2–3 mm long, white and conspicuous, not quickly deciduous, as large or larger than the sepals; stamens 6; styles longer than the apical fruit margin. …….. **Lepidium thurberi**
1. Pedicels moderately to strongly flattened; petals less than 1.5 mm long, whitish but rather inconspicuous, quickly deciduous, smaller and thinner than the sepals, or rudimentary or sometimes absent; stamens mostly 2 with additional rudimentary stamens (4 or 6 stamens sometimes present); stigma sessile or nearly so, or the styles short and not exceeding the apical fruit margin (see notes farther on).

2. Fruiting pedicels strongly flattened, usually pubescent on both the upper and lower surfaces; sepals usually quickly deciduous; fruits usually pubescent, sometimes only on the margins, the apical notch 0.2–0.7 mm deep…… **Lepidium lasiocarpum**
2. Fruiting pedicels only slightly flattened, pubescent on the upper surfaces, glabrous on the lower surfaces; sepals tardily deciduous to somewhat persistent; fruits usually glabrous, the apical notch 0.2–0.3 mm deep…… **Lepidium oblongum**

Lepidium lasiocarpum Nuttall ex Torrey & A. Gray
[*L. lasiocarpum* var. *georgimum* C.L. Hitchcock]
Sand peppergrass; *lentejilla*; ka:kowani. Figure 14.

Plants hirsute or hispid, 5–20 (40) cm, larger plants much-branched. Early leaves in a basal rosette, 2.5–6+ cm long, oblanceolate, bipinnatifid, quickly withering as stems develop; stem leaves smaller. Racemes mostly 2–10+ cm long, often crowded on larger plants. Fruiting pedicels conspicuously flattened (even on buds), usually pubescent on both the upper and lower surfaces. Flowers inconspicuous, probably mainly autogamous (selfing); sepals 1–1.5 mm long; petals white, quickly deciduous, smaller and thinner than the sepals, rudimentary, or sometimes absent; stamens 2 (4 or 6; abortive stamens often present on flowers with fewer than 6 stamens). Fruits nearly orbicular, strongly compressed (flattened), 3–4 mm long, notched at the apex, producing a relatively deep sinus with an essentially sessile stigma at its base, which seems to be a reliable key character.

One of the most common and widespread winter-spring ephemerals, mostly in washes and flats, and less common on rocky slopes. It has been in the region for at least 10,400 years.

Southwestern United States and northwestern Mexico.

The herbage of this and other species in the genus has been used in many places as a spicy condiment, hence the name "pepper grass," and as cooked greens or for salads (Hodgson 2001; Uphof 1968). The Seris used it for the chili-like flavor (Felger & Moser 1985). Chew on the fresh herbage or dry fruits and seeds and you will get a pleasantly sharp chili flavor.

The plants are highly variable depending on factors such soil moisture, shading, and stage of development. Young, vigorous plants can be very leafy, while older or drought-stressed plants are leafless or nearly so, and there is likewise much variation in pubescence, size and/or number of petals, and number of stamens. The flowers are autogamous but perhaps not always, especially with

favorable conditions. This variation seems to have led to problems in identification. Rollins (1993) recognizes four varieties and Al-Shehbaz and Gaskin (2010) recognize 3 subspecies, but the varieties seem only weakly differentiated and not worthy of recognition.

Figure 14. *Lepidium lasiocarpum*. (A) Ajo, 25 Mar 2013. (B) Alamo Canyon, 26 Feb 2014. (C & D) Engineer Canyon, Burro Mts, Grant Co., NM, 17 Mar 2010, photos by Russell Kleinman (gilaflora.com). (E) East of Tinajas Altas, 2 Mar 2014, photo by Sue Carnahan.

We are unable to realistically distinguish *Lepidium densiflorum* Schrader from *L. lasiocarpum*. These plants are often autogamous and polyploids of hybrid origin can be weakly differentiated, or sometime well differentiated. Environmental factors may also play a role in the confusing array of variability. Some populations that might be placed with *L. densiflorum* appear morphologically intermediate with between *L. lasiocarpum* and *L. virginicum* Linnaeus, raising the speculation that the plants might be of hybrid origin. *Lepidium virginicum* is widespread and occurs in Arizona east of the flora area.

We have been struggling with aspects of northern Mexico and southern Arizona *Lepidium* taxonomy for some time. A paragraph from Hitchcock's article (1945: 133) echoes what we have found in trying to figure out this taxonomic tangle:

> In general, *L. lasiocarpum* can be recognized from our other species because of the pubescent fruits, stiff pubescence, and flattened pedicels. However, the species is apparently in an extremely unstable condition, and great variation is to be found in every attribute, which has been thought to characterize it. Especially is this true in Mexico where it simulates or actually merges with such apparently different species as *virginicum* (var. *pubescens*), *densiflorum*, *dictyotum*, and *oblongum*, the evidence indicating that this is due in part, at least, to hybridization.

We agree with Hitchcock and what can, for the most part, be sorted out in Arizona falls to pieces in Mexico. For example, when you look at specimens variously identified as *L. densiflorum*, *L. lasiocarpum*, and/or *L. virginicum* you find every conceivable intermediate between all of them, so that separation is only artificial along a continuum. What makes this problem irritating from a taxonomic point of view makes it interesting from an ecological and evolutionary standpoint. We might ask: What is the distinction here between "hybridization" and points on a continuum of intergrading variation?

OP: Growler Valley, 20 Mar 1933, *Shreve 6203*. Canyon Diablo, 21 Mar 1935, *Kearney 10826*. Puerto Blanco Mts, *Nichol 25 Feb 1939*. Alamo Canyon, 14 Mar 1941, *Benson* 10674; 23 Mar 1941, *McDougall 22*. Dripping Springs, 28 Jan 1978, *Bowers 1018*. Arch Canyon, 3050 ft, 25 Feb 1978, *Bowers 1063*. Gachado Line Camp, 28 Jan 1978, *Bowers 1014*. Quitobaquito, 14 Apr 1963, *Felger 7679*. †Alamo Canyon, fruits, one with a flattened pedicel, 8130 ybp.

CP: Charlie Bell Well, *Johnson 26 Mar 1960*. 12 mi N of Christmas Pass, 13 Apr 1992, *Harlan 261*. Pinta Sands, 11 Apr 1993, *Felger 93-426*. San Cristobal Wash, 20 Mar 1992, *Harlan 14*.

TA: Tinajas Altas, wash floor above tanks, *Van Devender 10 Mar 1980*. Coyote Water, 21 Feb 2005, *Felger 05-130*. †Butler Mts, fruits with flattened pedicels, seeds, 8160 & 10,360 ybp.

Lepidium oblongum Small
Veiny pepperweed

Annuals, hirsute. Stems usually several from base, ascending, erect, to decumbent, to 30 cm long. Basal leaves not rosette forming, petiolate, once to twice pinnatifid, to 3.5 cm long. Fruiting pedicels 2–3.5 (5) mm long, pubescent on the upper surfaces, glabrous on the lower surfaces. Flowers inconspicuous, probably mainly autogamous, the sepals tardily deciduous to somewhat persistent, ca. 1 mm long, the petals absent or rudimentary, the stamens 2, the anthers minute. Fruits strongly compressed (flattened), orbicular, 2.2–3.5 × 2–3 mm, the style essentially sessile and included in the apical notch.

In the flora area known from Quitobaquito and Gunsight when both places were occupied.

California to Alabama, Mexico to Central America; washes, roadsides and other disturbed areas. Easily confused with, but less common than *Lepidium lasiocarpum*, with which it sometimes grows sympatrically and may hybridize.

OP: Quitobaquito, 17 Mar 1945, *Darrow 2406*.
Pima Co.: Gunsight, 3 mi E of Organ Pipe Cactus Nat. Mon., 14 Mar 1941, *Benson 10645*.

Lepidium thurberi Wooton
Arizona peppergrass. Figure 15.

Ephemerals or annuals, often from one stem and branched above, pubescent with white hairs to 1 mm long. Basal leaves in a rosette, often withered by flowering time, to 15 cm long, the blade pinnatifid with toothed-sinuate margins. Fruiting pedicels slender and terete, ascending to horizontal, 4–10 mm long. Flowers attractive, the petals white, 3–4 mm long; stamens 6. Fruits strongly compressed (flattened), glabrous, ovate to orbicular, 2–2.9 × 2–2.8 mm, the style 0.3–0.8 mm long, extending beyond the apical notch.

Figure 15. *Lepidium thurberi*. Newby Road, Burro Mts, Grant Co., NM, 7 Jun 2009, photos by Russell Kleinman (gilaflora.com).

Northern part of Organ Pipe, and perhaps the eastern margin of Cabeza Prieta near Jose Juan Hill. The seeds were eaten in the Tohono O'odham Region (Castetter & Underhill 1935).

California to New Mexico, Sonora, Chihuahua, and Coahuila.

OP: Near Bates Well, 25 Mar 1941, *McDougall 32*. Organ Pipe, *Walden 19 Apr 1964*. Cuerda de Leña Wash at N boundary, 31 Mar 1978, *Bowers 1158*. Jose Juan Hill, *Jackson? 7 Mar 1986* (ORPI).

†Lepidium sp./spp.

One or more members of this genus have been in the flora area for more than 18,700 years.

OP: †Puerto Blanco Mts, 980 to 10,540 ybp (4 samples).
TA: †Butler Mts, fruit (shaped like that of *L. lasiocarpum*), 11,250 ybp. Tinajas Altas, fruits, seeds, 8700 to 18,700 ybp (5 samples).

Lyrocarpa

Southwestern United States and northwestern Mexico; 3 species.

Lyrocarpa coulteri Hooker & Harvey
Lyre-pod; ban censañig. Figure 16.

Weak-stemmed herbaceous perennials, sometimes flowering in the first season; with stellate or candelabra-shaped hairs. Growing and flowering at various seasons with sufficient moisture. Stems slender and brittle, often 30–75 cm long. Leaves petioled, variable depending on shading, soil moisture, and position on stem, the blades thinner during wet periods, mostly 2.5–7 (11) cm long, pinnately lobed to deeply divided, mostly with (2) 3 (4) pairs of major segments. Flowers on racemes (4) 7–45 cm long; petals often twisted, linear-attenuate, extending 12–20 mm beyond the calyx, yellow-green, or yellow-brown to purple-brown, becoming darker with age. Fruits 10–28 × 8–14 mm, highly variable, broadly eliptic, obovate, or lyre-shaped, green, compressed but relatively thick, usually notched and widest at top. Seeds not mucilaginous.

Figure 16. *Lyrocarpa coulteri*. Estes Canyon: (A) 3 Apr 2010; (B) 30 Jan 2014; (C & D) 29 Feb 2008; (E) 16 Feb 2005.

The flowers are especially fragrant at night. Walking up Eagle Tank Arroyo in Cabeza Prieta at 9:30 p.m. on 26 February 1993, every so often Felger caught a whiff of a strong, strange, sweet fragrance. Up close it was even stronger, like banana esters, and came from perennial mounds of *Lyrocarpa* lining the arroyo bank.

Widespread across the flora area; often growing in the protection of large rocks and beneath shrubs and desert trees such as *Olneya*; washes, canyons, gravelly bajadas, and rocky slopes of hills and mountains.

Southern Arizona, southeastern California, western Sonora southward to the vicinity of Guaymas and both states of Baja California.

Lyrocarpa is the only perennial as well as non-seasonal (flowering and growth response) member of the mustard family that extends into the drier areas of the Sonoran Desert. *Lyrocarpa coulteri* seems to be closely related to *L. linearifolia* Rollins of islands in the Gulf of California.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Bates Well, 5 Mar 1940, *Benson 9911*. Dripping Springs, 16 Apr 1952, *Parker 7914*. Aguajita, 6 Apr 1988, *Felger 88-277*.

CP: Pinacate Flats, 3 Dec 1935, *Goodding 1554*. Papago Well region, 13 Feb 1942, *Goodding 9-42*. Near Agua Dulce Pass, *Simmons 13 Apr 1964* (CAB). Christmas Pass, *Van Devender 9 Mar 1980*. N side of Tule Mts, 2 Feb 1992, *Felger 92-48*.

TA: Tinajas Altas: 29 Mar 1930, *Harrison 6563; Van Devender 36 Mar 1983*.

***Matthiola**

Native to the Old World; 50 species.

****Matthiola longipetala** (Ventenat) de Candolle
[*M. bicornis* (Sibthorp & Smith) de Candolle]
Night-scented stock. Figure 17.

Figure 17. *Matthiola longipetala*. Hwy 85 near Three Points (Robles Junction), Pima Co., 2 Apr 2005.

Ephemerals with branched hairs. The first leaves not forming a basal rosette. Flowers pink and highly fragrant, especially fragrant at night; petals 15–20+ mm long. Fruits slender and straight, often more than 5 cm long.

Documented in Organ Pipe in the residence area, from a wildflower seed mix, and a single observation that same year on Hwy 85 about 200 meters north of the entrance to the visitor center, and doubtfully established. This species is a beautiful garden plant that produces prolific seed and easily escapes/spreads given suitable rainfall.

Native to Eurasia and sporadically established in North America as far north as Canada, and often cultivated.

OP: Residence area near visitor center, growing from a wildflower seed mix, *Rutman 27 Apr 2005*.

***Nasturtium** – Watercress
North America to Central America, Eurasia, and north Africa; 5 species.

****Nasturtium officinale** W.T. Aiton
[*Rorippa nasturtium-aquaticum* (Linnaeus) Hayek]
Watercress; *berro*. Figure 18.
Perennial herbs; probably emergent from shallow water, at Dripping Springs and Williams Spring and no longer present in the flora area. Watercress was probably planted at these springs.

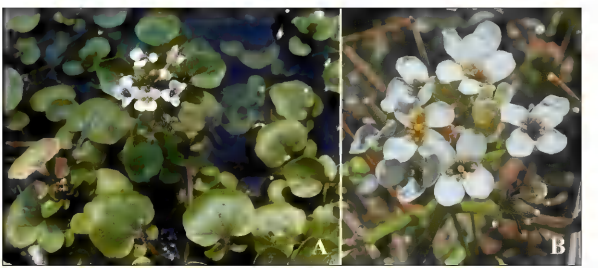

Figure 18. *Nasturtium officinale*. (A) Harshaw Creek, Santa Cruz Co., 26 May 2013, photo by Tom Van Devender. (B) Gold Gulch Spring, Burro Mts, Grant Co., NM, 10 Apr 2009, photo by Russell Kleinman (gilaflora.com).

The plants at Dripping Springs were destroyed by the multitudes of illegal border crossers in the latter part of the 20th century. The Williams Spring watercress died out probably sometime before the mid-20th century (Felger et al. 1992).

Native to the Old World; temperate and subtropical regions worldwide and widely cultivated; naturalized in many southern Arizona and northern Sonora streams.

OP: Bobby Gray (*in* Hoy 1970) reported that in the late nineteenth century watercress grew at Williams Spring; Henry Gray (interviewed by Joyce Kelso in 1975, a National Park Service employee; on file at Organ Pipe Cactus National Monument) in talking about watercress at Dripping Springs said, "It was awful good. . . I'd eat a lot of it."

Physaria – Bladderpod

North America and southern South America, and northeast Russia; 106 species.

Physaria tenella (A. Nelson) O'Kane & Al-Shehbaz
[*Lesquerella tenella* A. Nelson]
Desert bladderpod. Figure 19.

Cool-season ephemerals, silvery green from a covering of stellate hairs that are spectacular under high magnification. Stems mostly 15–60 cm long. Basal-rosette leaves and lower stem leaves often 3–9 cm long, petioled, the blades narrowly elliptic to obovate. Fruiting pedicels S-shaped, often (10) 15–18 mm long. Flowers in racemes (3) 9–20 cm long, the flowers bright yellow, the petals 8–10+ mm long. Fruits globose and bladder-like, 3.5–4.8 mm wide; ovaries and fruits with small stellate hairs on the surface. Seeds flattened, the margin a thickened, cord-like rim or narrow wing; mucilaginous when wet, especially from the rim margin.

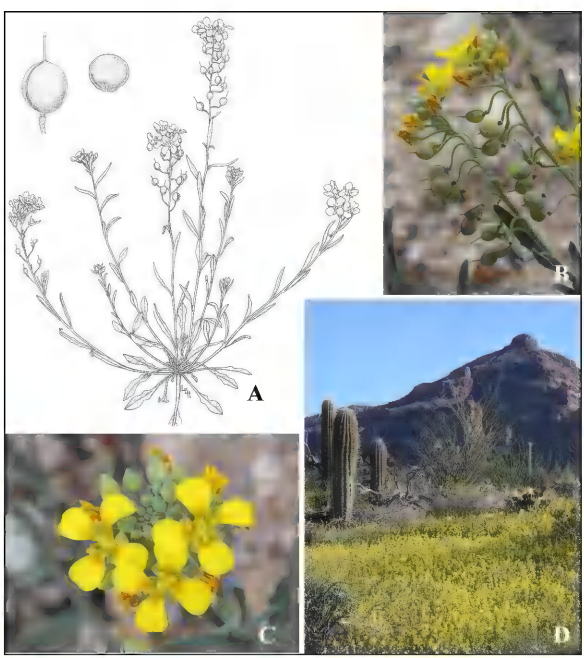

Figure 19. *Physaria tenella*. (A) By Lucretia Breazeale Hamilton. (B & C) Hwy 86 W of Robles Junction, Pima Co., 22 Feb 2014. (D) Bajada W of Ajo Mts, 2 Mar 2008.

Widespread, especially at lower elevations; washes, sand flats, valley plains, and mountains, often growing in the protection of small shrubs. In favorable years carpeting the desert with yellow.

Southwestern Utah, southern Nevada, southeastern California, western and southern Arizona, northern Sonora, and Baja California.

OP: Tres Alamos Canyon, 2700 ft, *Nichol 24 Feb 1939.* 5 mi N of Sonoyta, 22 Mar 1941, *McDougall 15.* 6 mi E of Hwy 85 on Camino Dos Republicas, 11 Feb 1978, *Bowers 1040.* Puerto Blanco Mts, 30 Mar 1980, *Stimson 204.*

CP: N side of Tule Mts, 2 Feb 1992, *Felger 92-60.* Charlie Bell Pass, 3 Apr 1992, *Whipple 3919.* Childs Mt, 25 Feb 1993, *Felger 93-33.* 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002.*

TA: Tinajas Altas, *Van Devender 5 Mar 1983.* Tinajas Altas canyon above uppermost tinaja, 19 Mar 1998, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-58.*

Planodes

This genus has two species. *Planodes mexicana* (S. Watson) Al-Shehbaz occurs in southern Mexico.

Planodes virginicum (Linnaeus) Greene
[*Sibara virginica* (Linnaeus) Rollins]
Virginia winged rockcress. Figure 20.

Pubescent or glabrous, cool season ephemerals, the stems erect or ascending to decumbent. Basal leaves in a loose rosette, persistent, the blades pinnatifid to pinnatisect with (4) 6–12 (15) lobes per side. Cauline leaves similar to the basal leaves, but smaller. Fruiting pedicels 1.5–6 (8) mm long. Flowers 2–3 mm long, white. Fruits divaricate-ascending, (1) 1.5–2.5 (3.2) mm long, 1–1.5 mm wide. Seeds winged.

Figure 20. *Planodes virginicum.* Floodplain of Santa Cruz River, San Rafael State Park, Santa Cruz Co., 20 Apr 2001, *McLaughlin 9249* (ASU).

The Las Playas collection is the only known record for this species within the Sonoran Desert.

Widespread and often weedy across the United States and in Baja California, and expected in parts of northern Sonora.

CP: Las Playas, S end, 1 Mar 1998, *Harlan 495*.

Sibara – Winged rockcress

Southwest United States and northern Mexico; 13 species. The one species in the flora area, known from only a single specimen, is a notable extralimital record. Seeds not mucilaginous when wet.

Sibara angelorum (S. Watson) Greene

Figure 21.

Glabrous spring ephemerals to 70 cm high, single-stemmed and branched above. Leaves pinnate with linear segments, the basal leaves usually withering by the time the plants are flowering. Fruiting pedicels 8–15 mm long, widely spreading to somewhat arched downward. Flowers probably 5–8 mm long, pale lavender to purplish, and rather inconspicuous. Fruits slender, 2.5–4.5 cm long (the Lehto specimen has fruit 3.7 cm long), 1.5 mm wide. Seeds wingless.

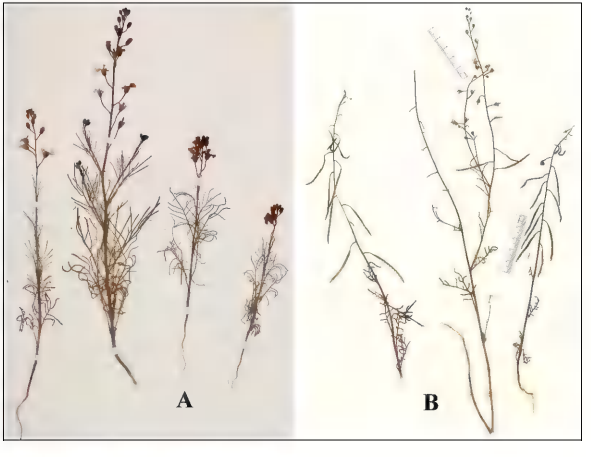

Figure 21. *Sibara angelorum*. (A) "East of Punta Eugenia, Baja California" [NW Baja California Sur, 27°48'N, 115°01'W], 13 Mar 1949, *Gentry 8683* (ASU). (B) Cabeza Prieta Tank, 6 Nov 1979, *Lehto L23523* (ASU).

This species is recorded for the United States by the one Cabeza Prieta specimen (Felger et al. 2007). Known from both Baja California states, and coastal Sonora but not in the northwestern part near the flora area.

CP: Cabeza Prieta Tanks, canyon, S10, T13, R15W, 6 Apr 1979, *Lehto L23523* (ASU).

***Sisymbrium** – Hedge-mustard, rocket

Cool-season ephemerals. Plants glabrous or with simple hairs. Flowers small and usually yellow. Fruits narrowly linear, terete or slightly flattened. Seeds not mucilaginous when wet.

North America, Eurasia, and Africa, and widely introduced; 41 species.

1. Pedicels slender, noticeably more slender than the fruit; flowers and fruits glabrous; petals 3–4 mm long; fruits (1.8) 3–5 cm long, 0.8–1.3 mm wide; widespread and common…….…… **Sisymbrium irio**
1. Pedicels relatively thick, about as thick as the fruit; flowers and fruits glabrous or not; petals 5–10 mm long; fruits 3–10+ cm long, 1–2 mm wide; roadsides, localized and not common.

2. Upper stem leaves pinnately divided into narrowly linear segments including the terminal one; fruiting pedicels 4–13 mm long ..... **Sisymbrium altissimum**
2. Upper stems leaves pinnately divided but the segments not all narrowly linear; fruiting pedicels 3–6 mm long..... **Sisymbrium orientale**

****Sisymbrium altissimum** Linnaeus

Tall tumble-mustard, tumble mustard, Jim Hill mustard. Figure 22.

Plants sometimes to nearly 1.5 m tall, usually hairy below and glabrous above, the hairs simple. Basal leaves pinnatifid, to 15 cm long. Upper cauline leaves pinnately divided into narrowly linear lobes. Fruiting pedicels spreading, (4) 6–10 (13) mm long. Petals 5–8 (10) mm long, pale yellow. Fruits linear, (4.5) 6–9 (12) cm × 1–2 mm; ovules 90–120 per ovary.

In the flora area known from plants growing at a roadside construction site in 2005. We presumed this species was no longer present after 2005, but then Sue Rutman found it again along highway 85 in late spring 2011.

In Arizona almost entirely above the desert and mostly in the northern part of the state. Native to Eurasia and widespread in temperate region of North America.

OP: Hwy 85 at milepost 68.7, 6.5 mi N of Park headquarters, plants in imported soil at construction site, 15 Mar 2005, *Rutman 2005-0315* (ORPI).

***Sisymbrium irio** Linnaeus

London rocket; *pamitón*; ban cinsañig. Figure 23.

Plants generally taller than wide, glabrous or sparsely pubescent on part of the herbage and pedicels, the hairs simple. Leaves highly variable, bright green, early leaves in a rosette, the stem leaves well developed but reduced upwards; leaves petioled, pinnatifid, the larger ones (3) 7–20 cm long, the blades thin. Flowering stems usually branched. Fruiting pedicels very slender and spreading, 5–14 mm long. Petals, filaments, and anthers pale yellow; petals 3–4 mm long. Fruits linear, (1.8) 3–5 cm × 0.8–1.3 mm; ovules 40–90 per ovary. Seeds yellow-orange and not mucilaginous.

Widespread and common; mostly along washes, canyon bottoms, desert plains beneath trees, and similar habitats on mountains, often in natural areas but especially in disturbed habitats.

Native to Europe and now invasive and weedy worldwide.

OP: Canyon Diablo, 21 Mar 1933, *Kearney 10830*. Alamo Canyon, 26 Mar 1941, *McDougall 26*. Quitobaquito, 6 Apr 1988, *Felger 88–278*. Residence area (headquarters), 30 Mar 1988, *Felger 88–140*.

CP: Tule Tank, 2 Feb 1992, *Felger 92–64*. Childs Mt, 2240 ft, 25 Feb 1993, *Felger 93–44*. Redtail Tank, *Griffin 02/03/1995* (CAB).

Figure 22. *Sisymbrium altissimum*. (A, B & E) Ajo Mountains wayside construction site (3 mi S of N boundary of Organ Pipe), Hwy 85, 13 April 2005. (C) Sedona, Yavapai Co., 14 Apr 2001, photo by Max Licher (SEINet). (D) Apache Creek, Catron Co., NM, 7 Jul 2009, photo by Russell Kleinman (gilaflora.com).

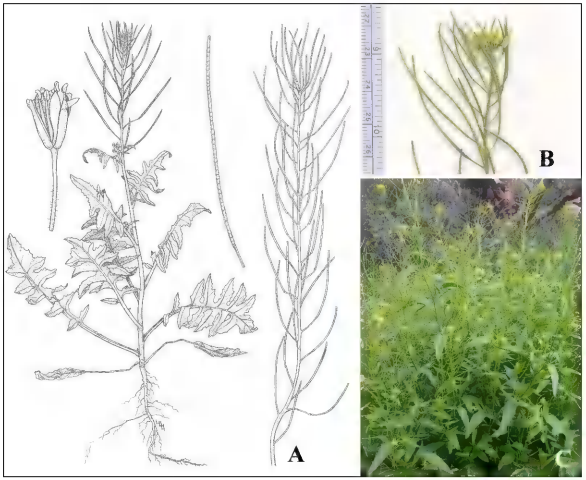

Figure 23. *Sisymbrium irio*. (A) By Lucretia Breazeale Hamilton. (B) Alamo Canyon, 11 Mar 2014. (C) Estes Canyon, 16 Feb 2005.

****Sisymbrium orientale** Linnaeus
Indian hedge-mustard. Figure 24.

Plants to 1 m tall, glabrous or pubescent, the hairs simple. Basal leaves in a rosette, petioled, pinnately lobed, to 20 cm long, often relatively thick and coarse; cauline leaves hastate, with 1 or 2 lobes on each side. Fruiting pedicels ascending to divaricate, about as wide as the fruit, 3–6 mm long. Petals 6–10 mm long, lemon yellow. Fruits linear, 5–13 cm × 1–1.5 mm; ovules (60)–100 (140) per ovary. The flowers are larger and brighter yellow than those of *S. irio*.

Well established in disturbed habitats at Ajo and Why, and found growing at a construction site along Highway 85 in Organ Pipe in 2005 and later at several places along the highway. So far it has not established within the core flora area.

Native to the Mediterranean region of Europe. A potentially invasive species; it is widespread in southern and western Arizona. The earliest Arizona specimen is from 1931 and there have been many Arizona collections since 1963. Weedy in many regions worldwide including the Americas.

OP: Ariz State Rte 85, 6.5 mi N of Park headquarters, dozens of plants at a construction site, 15 Mar 2005, *Rutman 2005-0315-1*.

CP: Refuge headquarters at Ajo, 9 Apr 2005, *Felger 05-158*.

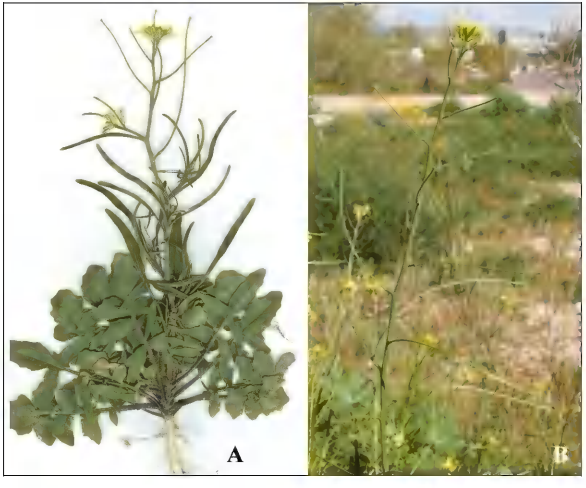

Figure 24. *Sisymbrium orientale*. Ajo: (A) 15 Mar 2008; (B) 26 Feb 2005.

Streptanthella, see **Streptanthus**

Streptanthus – Jewel-flower

Central and western United States and northern Mexico; 54 species. Al-Shehbaz (2012) and Cacho et al. (2014) show that *Caulanthus* and *Streptanthella* are included in a monophyletic *Streptanthus*.

1. Stem (cauline) leaves clasping; flowers showy, the petals 14–18 mm long; fruits flattened, 4–6 mm wide..... **Streptanthus carinatus**
1. Stem leaves not clasping; flowers not showy, the petals 2.3–5 mm long; fruits flattened or terete, less than 2 mm wide.

2. Leaves or leaf lobes not linear; petals 2.3–4.5 mm long; fruiting pedicels not curved; fruits 0.7–1.2 mm wide, turned downward at maturity..... **Streptanthus lasiophyllus**
2. Leaves or leaf lobes linear; petals 4–5 mm long; fruiting pedicels usually curved; fruits 1.4–1.6 mm wide; spreading or sometimes turned downward at maturity..... **Streptanthus longirostris**

Streptanthus carinatus C. Wright ex A. Gray subsp. **arizonicus** (S. Watson) Kruckenberg, Rodman, & Worthington
[*S. arizonicus* var. *luteus* Kearney & Peebles]
Arizona jewel-flower. Figure 25.

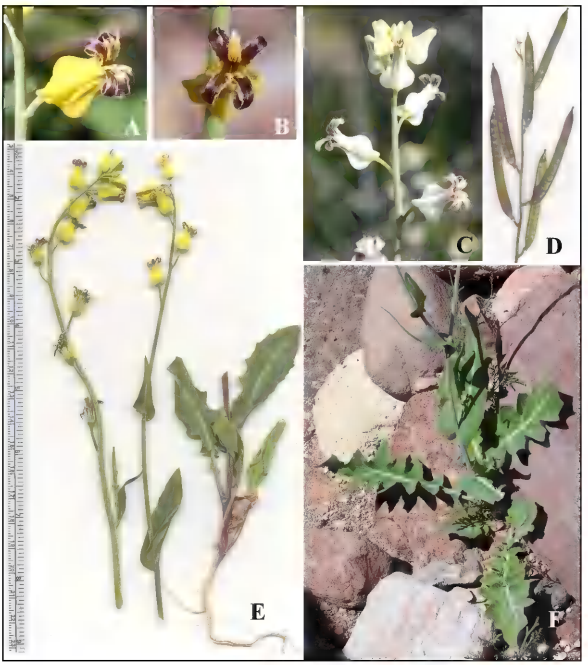

Figure 25. *Streptanthus carinatus* subsp. *arizonicus*. Estes Canyon: (A & E) 2 Mar 2008; (D) 19 Mar 2012. (B & F) Alamo Canyon, 26 Feb 2014. (C) Gunsight Hills near Kuakatch, 3 Mar 2005.

Glabrous spring ephemerals. Early leaves in a basal rosette, the rosette and lower stem leaves highly variable, ovate, oblanceolate, or pinnatifid, 5–25 cm long, the cauline leaf blade bases clasping the stem; leaves reduced above. Fruiting pedicels divaricate to ascending, 7–22 (35) mm long. Flowers 8–11 mm long, the calyx urn-shaped, white or yellow, the petals slender, recurved at tips, 14–18 mm long, whitish often with purple veins or purple with white margins. Fruits flattened, 3–6 cm long, 4–6 mm wide; ovules 26–54 per ovary. Seeds winged, not mucilaginous.

Mountain canyons and rocky slopes in Organ Pipe including the Ajo, Diablo, Puerto Blanco, and Santa Rosa mountains, and sometimes in larger washes running out from mountains.

Arizona to Texas and northern Mexico including Baja California.

OP: Alamo Canyon, *Nichol 26 Mar 1939*. W-facing slope SE of Bull Pasture near Sphinx Head, 28 Feb 1989, *Baker 7701* (ORPI). Arch Canyon, 2 Dec 1990, *Felger 90–511*. Kuakatch Wash near E boundary, 2 Mar 2003, *Rutman 2003-210* (ORPI). Santa Rosa Mts, 11 Mar 2003, *Felger 03-307*. Trail from The Cones to Mount Ajo, 3940 ft, 10 Apr 2005, *Felger 05-260*.

Streptanthus lasiophyllus (Hooker & Arnott) Hoover
[*Caulanthus lasiophyllus* (Hooker & Arnott) Payson; *Guillenia lasiophylla* (Hooker & Arnott) Greene; *Thelypodium lasiophyllum* (Hooker & Arnott) Greene]
California mustard. Figure 26.

Figure 26. *Streptanthus lasiophyllus*. (A) Ajo, 6 Mar 2008. (B) Kuakatch Wash near Hwy 85, 4 Feb 2005. (C) Estes Canyon, 18 Mar 2005. (D) Aguajita Wash, 4 Feb 2005.

Cool-season ephemerals, erect-growing, (8) 10–60 cm tall, mostly branched from above, sparsely to densely hispid or hirsute (rarely sub-glabrate) with simple hairs. Leaves pinnatifid, (2) 4–12 cm long, the plants often becoming leafless as fruits mature. Fruiting pedicels reflexed to spreading, 0.7–3 mm long. Flowers in elongated racemes, petals white to pinkish or purplish, (2.3)

2.5–4.5 mm long. Fruits (1.8) 2.5–3.5 (4.2) cm long, slender, straight, and terete, turning downward as they mature and dehisce; ovules 14–60 per ovary. Seeds ca. 1 mm long, not mucilaginous.

Widespread through the flora area, valley plains and mountains; one of the most common mustards in Cabeza Prieta.

Western Sonora through Arizona to Utah, and Baja California to western Washington.

OP: Alamo, Ajo Mts, 2500 ft, *Nichol 14 Mar 1939.* Sierra de Santa Rosa, 1600–2200 ft, 11 Feb 1978, *Bowers 1026.* Arch Canyon, 2900 ft, 11 Mar 1983, *Daniel 2611* (ASU). Cuerda de Leña, 30 Mar 1981, *Butterwick 7127* (ASU). Quitobaquito, 29 Mar 1988, *Felger 88-133.*

CP: Mohawk Valley near point of the Pintas, *Simmons 7 Mar 1964* (CAB). Cholla Pass, 11 Apr 1978, *Reeves 6822* (ASU). Growler Valley, *Phelps 18 Mar 1978* (ASU). Charlie Bell Pass, 3 Apr 1992, *Whipple 3951.* Childs Mt, 25 Feb 1993, *Felger 93-38.* Papago Well, 26 Feb 1993, *Felger 93-132.*

TA: Tinajas Altas Pass, 12 Feb 1977, *Reeves 5404* (ASU). Vicinity of Tinajas Altas, *Van Devender 5 Mar 1983.* Tinajas Altas Mts, above the tinajas, 19 Mar 1998, *Felger* (observation). Coyote Water, *Felger 05-131.*

Streptanthus longirostris (S. Watson) S. Watson
[*Streptanthella longirostris* (S. Watson) Rydberg]
Long-beak twist-flower. Figure 27.

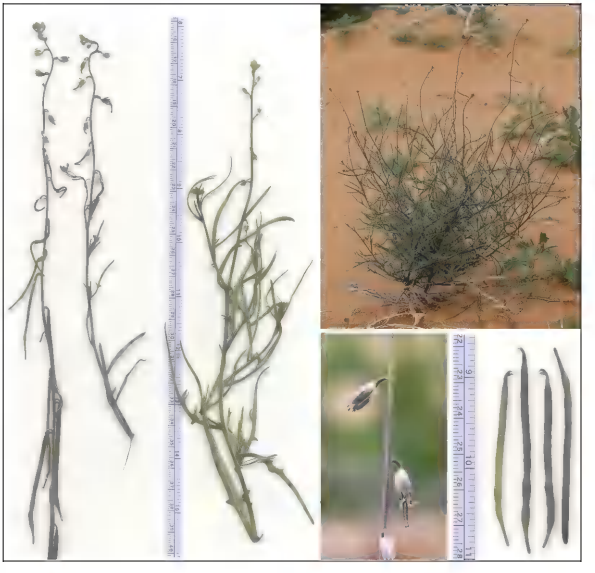

Figure 27. *Streptanthus longirostris.* Dunes, 20 mi SW of Sonoyta, Sonora, 6 Feb 2014.

Cool-season ephemerals, glabrous, 18–60 cm tall, simple to much-branched, the branches ascending. Stems leafy; fresh herbage bluish glaucous, the leaves often thick. Lower leaves largest, narrowly lanceolate, 2.5–10.5 × 0.1–2.2 cm, mostly pinnately parted with a few slender lobes; upper leaves lanceolate to oblanceolate or linear and entire, the margins entire, dentate to sinuate or pinnatifid. Racemes 4–20+ cm long. Fruiting pedicels 1–5 (7) mm long, usually curved. Flower buds with a few appressed 2-armed hairs. Flowers small, the petals 4–5 mm long, linear, often white and maroon. Fruits slender, terete, and long-beaked, 2.4–6.5 cm × 1.4–1.6 mm. Seeds narrowly winged, 2–3 mm long, not mucilaginous.

Known for certain in sand and silt soils of washes, flats, and dunes in the southern part of Cabeza Prieta, especially the Pinta Sands. It is widespread in the Goldwater Range and adjacent northwestern Sonoran including the extremely arid Sierra del Rosario (Felger 2000), and is expected from Tinajas Altas eastward.

Western United States, especially in the Southwest, and Mexico in Baja California and northern Sonora.

CP: N Pinta Tank (Simmons 1966). E side of Pinacate Lava Flow along Camino del Diablo, 1 Feb 1992, *Felger 92-20*. Pinta Sands, 1 Feb 1992, *Felger 92-38*. Dos Playas, 26 Feb 1993, *Felger 93-143*.

Thelypodium

West and west-central North America including northern Mexico; 16 species.

Thelypodium wrightii A. Gray

[*Stanleyella wrightii* (A. Gray) Rydberg]. Figure 28.

Ephemerals (or sometimes biennial?) reaching 2 m in height; glabrous. Leaves petiolate, the lower leaves pinnately lobed, the upper leaves toothed to entire. Fruiting pedicels (3) 4–6 (7) mm long. Petals purple and white or white, 4–7 (9) mm long. Fruits (2.5) 4–7 (9) cm long, slender and terete, constricted between the seeds; ovules 76–128 per ovary.

Higher elevations in the Ajo and Diablo mountains, often beneath trees and other shaded or protected habitats in canyon bottoms and north-facing slopes.

Arizona to Colorado, Utah, Oklahoma, Texas, and northern Mexico including Baja California. Flowering March to November.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Estes Canyon, *Hesselberg 16 Oct 1966*. Arch Canyon, *Pate 19 Nov 1994*.

***Thlaspi** – Pennycress

Eurasia and north Africa, and introduced nearly worldwide; 6 species.

****Thlaspi arvense** Linnaeus

Fanweed, roadside pennycress, field pennycress. Figure 29.

Cool-season, erect ephemerals to 80 cm high; glabrous. Leaf margins entire, repand or dentate. Fruiting pedicels (5) 9–13 (15) mm long. Petals white, (2.4) 3–5 mm long. Fruits rounded and strongly flattened, often 1–2 cm wide, the apex notched to 5 mm deep, the valves winged throughout; ovules 6–16 per ovary.

Known from the flora area by a single specimen, perhaps resulting from an accidental introduction by a visitor. *Salvia reflexa* (*Pinkava 9994*, ASU) is likewise known from a single collection in the flora area, from the same place, date, and collector.

Native to Eurasia and weedy worldwide.

OP: Campground, 25 Nov 1972, *Pinkava 9993* (ASU).
Yuma Co.: 28 mi W of Mohawk Pass on Ariz State Hwy 8, 17 Mar 1974, *McLaughlin 136*.

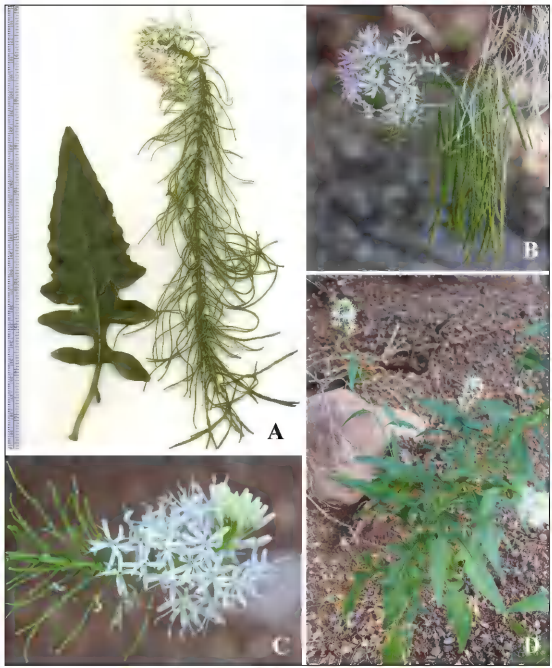

Figure 28. *Thelypodium wrightii*. Alamo Canyon: (A, C & D) 9 Sep 2013; (B) 12 Jan 2014.

Figure 29. *Thlaspi arvense*. (A & D) Nixon Spring, Mount Trumbull, Coconino Co., 4 Jun 1972, *Mason 3080*. (B & C) Gila Cliff Dwellings, Catron Co., NM, 26 May 2013, photos by Russell Kleinman (gilaflora.com).

Thysanocarpus – Fringepod, lacepod

Western North America including northwestern Mexico; 7 species.

Thysanocarpus curvipes Hooker

[*T. curvipes* var. *elegans* (Fischer & C.A. Meyer) B.L. Robinson; *T. amplectens* Greene]

Lacepod. Figure 30.

Cool-season ephemerals to 80 cm high. Early leaves in a basal rosette, leave highly variable, the larger ones 3–13 cm long, the cauline leaf bases clasping the stem. Fruiting pedicels recurved, 3–7 (12) mm long. Flowers minute, whitish, on racemes (4) 9–25 cm long. Fruits on slender curving pedicels and uniquely disk-shaped with broad margins, these entire or with small perforations or holes all the way around the fruit; ovule one per ovary.

Agua Dulce Mountains in Cabeza Prieta and widespread in Organ Pipe except the most arid areas such as the southwestern portion. Found among rocks, often on north-facing exposures on mountain slopes and in mountain washes. Its history in the flora area extends to more than 10,600 years, and this or a similar species was at Tinajas Altas more than 15,000 years ago.

Western North America including Baja California and northern Sonora.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10816*. Alamo Canyon: 2500 ft, *Nichol 14 Mar 1939*, 2800 ft, 28 Jan 1978, *Bowers 1008*. Ajo Mts, summit, 1 Apr 1944, Clark 11538 (ORPI). †Puerto Blanco Mts, fruits, 10,540 ybp.

CP: Below Agua Dulce Pass, 26 Feb 1993, *Felger 93-93*.

TA: †Butler Mts, 10,360 ybp. ††*T.* cf. *curvipes*, Tinajas Altas, 8970 to 15,050 ybp (8 samples).

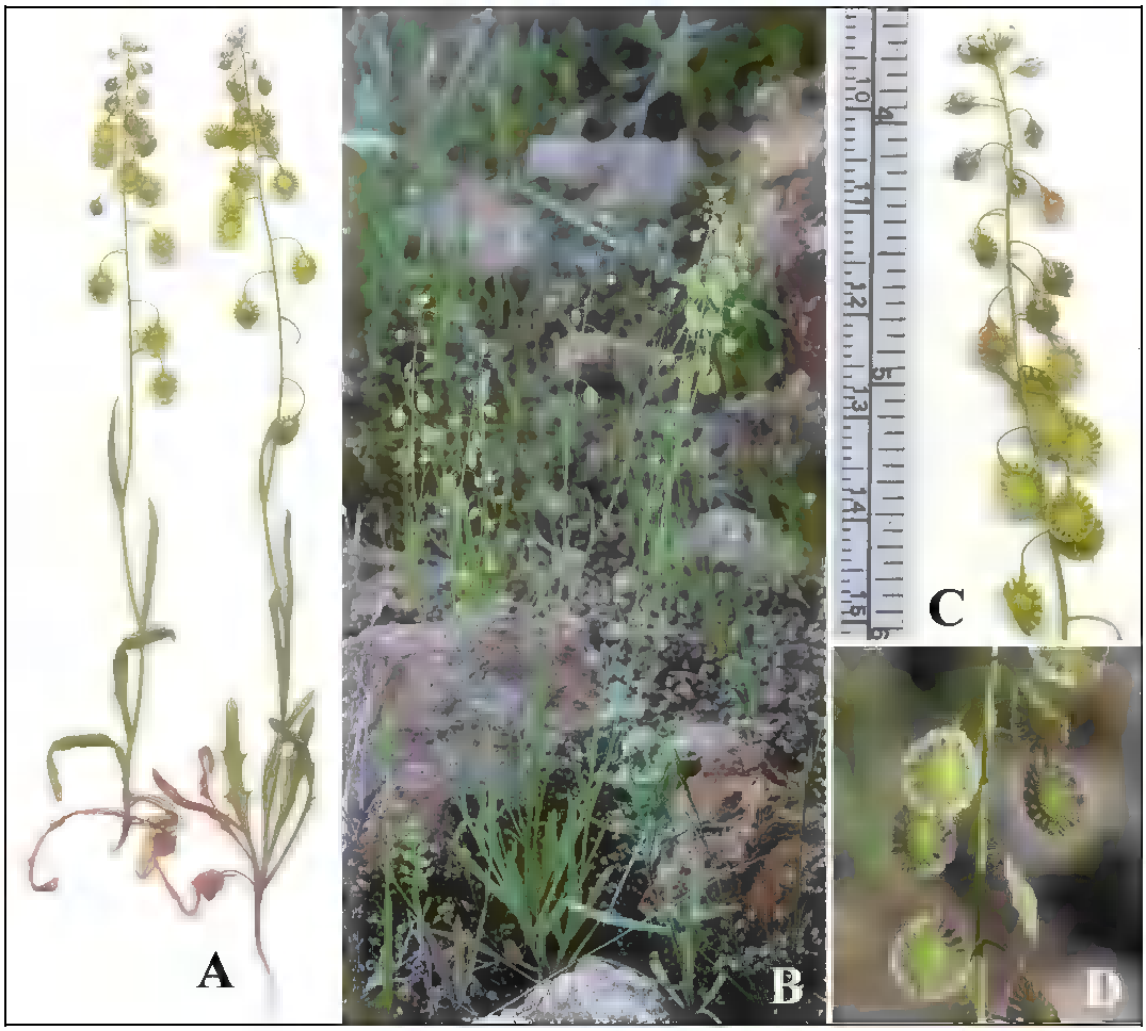

Figure 30. *Thysanocarpus curvipes*. Estes Canyon: (A & C) 2 Mar 2008; (D) 27 Feb 2014. (B) S fork of Alamo Canyon, 12 Mar 2005.

Tomostima

Six species in North and South America; segregated from *Draba* (Al-Shehbaz 2012; Jordon-Thaden et al. 2010).

Tomostima cuneifolia (Nuttall ex Torrey & A. Gray) Al-Shehbaz, M. Koch & Jordon-Thaden [*Draba cuneifolia* Nuttall ex Torrey & A. Gray; *D. cuneifolia* var. *integrifolia* S. Watson; *D. sonorae* Greene; *D. cuneifolia* var. *sonorae* (Greene) Parish; *Tomostima sonorae* (Greene) Al-Shehbaz, M. Koch & Jordon-Thaden]

Wedge-leaf draba. Figure 31.

Small winter-spring ephemerals with 2–4-rayed hairs. Leaves in a basal rosette, 5.5–45 × 2–18 mm, sessile, thin, broadly obovate with (1) 2 or 3 pairs of shallow, coarse teeth. Cauline leaves 0–6, restricted to the lower 1/3 of the stem. Flowering stems leafless; inflorescences (1.8) 3–15 cm. Fruiting pedicels 1–7 (10) mm long, horizontal to ascending. Flowers of two extremes, sometimes on the same plant, the smaller flowers with petals 1.2–1.5 mm long, the larger flowers with petals to 3 mm long; sepals and petals very quickly deciduous, the petals white. Fruits (4.5) 6–12 × (1.6) 2–2.7

mm, laterally flattened, with simple or 2–4-rayed hairs; ovules (12) 24–72 per ovary. Seeds 0.6–0.7 mm long, red-brown, mucilaginous when wet.

Seasonally common and widespread in washes, desert plains, sand flats, and rocky slopes especially in sheltered niches. This or a similar species grew at Tinajas Altas 11,000 years ago.

Much of the United States and northern Mexico including both states of Baja California and to southern Sonora and Zacatecas.

This species is distinguished from other Sonoran Desert crucifers by its broad and shallowly toothed basal leaves, small and leafless flowering stems, and relatively short, broad, and laterally flattened fruits. Rollins (1993) recognized 3 varieties of *Draba cuneifolia*, but these are not always well marked in the Sonoran Desert Region, are not geographically separate, and do not seem worthy of recognition. Many specimens from the flora area have the larger fruits characteristic of var. *integrifolia* but with the fruits extending nearly to the base of the inflorescence axis as in var. *sonorae*.

OP: Quitobaquito, *Nichol 10 Mar 1939*. Alamo Canyon, 28 Jan 1978, *Bowers 1006*. Gachado Line Camp, 28 Jan 1978, *Bowers 1012*.

CP: 6 mi E of Papago Well, 28 Feb 1976, *McManus, McLaughlin, & Fugate 1043*. Flats near Sheep Mts, Agua Dulce Mts, 18 Feb 1979, *McLaughlin 1953*. 1.8 mi N of Adobe Windmill, 25 Feb 1993, *Felger 93-62*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3947*. Childs Mt, 25 Feb 1993, *Felger 93-42*.

Figure 31. *Tomostima cuneifolia*. (A) Alamo Wash, 11 Mar 2014. (B) Armenta Ranch area, 13 Feb 2005.

TA: Base of Tinajas Altas, 29 Mar 1930, *Harrison 6580*. Frontera Canyon, 18 Mar 1998, *Felger* (observation). Camino del Diablo, SSE of Raven Butte, 20 Feb 2005, *Felger 05-36*. †*T.* cf. *cuneifolia*, Tinajas Altas, fruits, 10,950 ybp.

BURSERACEAE – Frankincense or Torchwood Family

Trees and shrubs with prominent resin ducts containing aromatic terpenes and essential oils. Flowers small, radial, often unisexual.

Tropical and subtropical regions of the Americas, Asia, and Africa; 20 genera, 600 species. Frankincense is derived from the resin of *Boswellia carteri* and related species, and myrrh from *Commiphora abyssinica* and related species. All members of the family are apparently frost sensitive. The family is most closely related to the Anacardiaceae.

Bursera

Americas, mostly semiarid subtropical scrub; *Bursera,* with 100 species, is the largest genus in the family. Mostly in Mexico, with maximum diversity along the Pacific slope where more than 80 species occur and 70 are endemic. Nine species in southern Sonora, 4 in the Guaymas Region, and 1 in the desert in northwestern Sonora and adjacent Arizona and southeastern California. The aromatic foliage and gum, or copal, have a long history of religious and medicinal uses.

Bursera microphylla A. Gray

Elephant tree; *torote*; ʻusabkam. Figure 32.

Tree-like shrubs, glabrous, often 1.5–4 m tall, with semi-succulent thick limbs and short, fat trunks; the wood very soft. A large *Bursera* in Frontera Canyon in the Tinajas Altas Mountains measured 4 m tall and 6 m across, with a trunk 110 cm tall and 130 cm in circumference. Deeply cut branches or roots ooze blood-red sap. The sap and herbage are pungently aromatic, being especially rich in terpenes and essential oils. Bark on twigs and smaller branches red-brown, becoming papery on larger limbs and trunks and peeling in large flakes or sheets, especially during spring dry season. Leaves drought deciduous, bright green, pinnate, mostly (1.5) 2–4 cm long, the rachis very narrowly winged; leaflets more or less linear-oblong to oval. Long shoots with relatively long internodes, leaves otherwise crowded at ends of short shoots; short-shoot leaves may appear several times per year at any season following even meager rainfall, except during the coldest weather; long shoots, growing with hot-weather rains, are briefly leafy in their first season. Many bursera plants in the flora area, especially in Organ Pipe, show signs of repeated freeze damage.

All or most of the plants are probably functionally dioecious. Flowers solitary or 2–several on slender stalks, cream-white or pale greenish yellow, 2 mm wide; sepals and petals usually 3 each on female flowers, and (4) 5 each on male flowers. Fruits 7–9 mm long, dull purple-brown and glaucous when fresh, the 3 leathery carpels splitting apart when fully ripe to reveal a red pseudo-aril enveloping the seed (see Bates 1992). Seeds 6 mm long, 3-angled. Flowering with emerging leaves in the first summer rains.

Rocky slopes and sometimes upper bajadas throughout Cabeza Prieta and Tinajas Altas to peak elevations. Widespread in Organ Pipe on mountain slopes and upper bajadas, often on west- and south-facing slopes. Its history in the region extends to 6000 years in the Tinajas Altas Mountains.

Sonoran Desert in southern Arizona and western Sonora to the vicinity of Guaymas, and southeastern California to the Cape Region of Baja California Sur.

The crushed leaves are highly aromatic. When a leaf is broken off of a turgid stem, a tiny jet of aromatic sap may squirt from the wound as an herbivore defense mechanism (Becerra 1994) . The aromatic foliage and sap have been widely used for medicinal and ritual purposes, including by the Cahuillas and Seris (Bean & Saubel 1972; Felger & Moser 1985; Rea 1977). Lumholtz (1912: 331) reported that "the root of the torote tree, crushed and left in water, furnished necessary material for the tanning" of mule deer, pronghorn, or bighorn sheep hides.

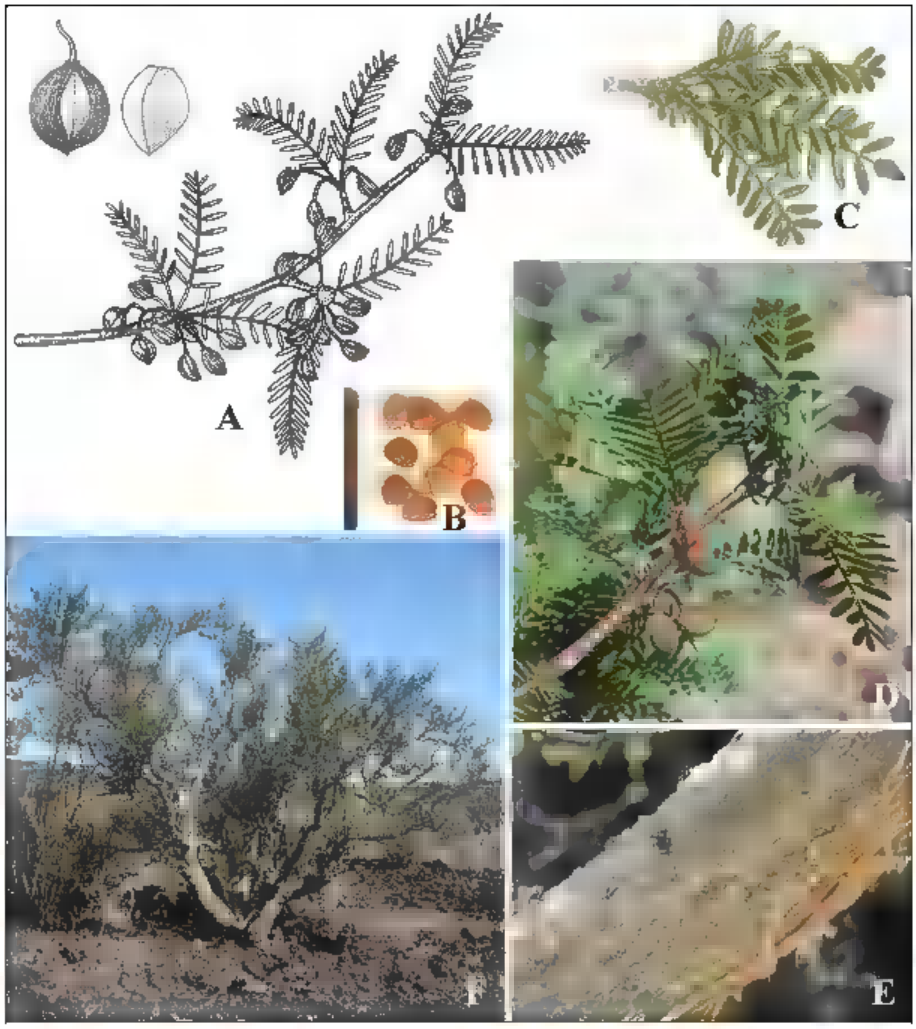

Figure 32. *Bursera microphylla*. (A) By Lucretia Breazeale Hamilton. Ajo: (B & C) 13 Jan 2008; (D) 6 Sep 2013. (E) Red Cone Campground, Pinacate Biosphere Reserve, Sonora, 13 Jan 2008. (F) Near Red Cone Campground, Sonora, 9 Mar 2009.

OP: Senita Basin, 26 Feb 1978, *Bowers 1095*. 5 km NW of Bates Well, 3 Dec 1990, *Felger 90–581*. W of Growler Pass, 7 Mar 2003, *Rutman 2003–248* (ORPI).

CP: Davidson Canyon, *Simmons 9 Oct 1962* (CAB). Tule Tank, 6 Apr 1979, *Lehto L-23551* (ASU). E end of Tule Mts, 20 Mar 1987, *Elias 10308*. Observations, 12–15 Jun 1992, *Felger*: Granite Mt, Granite Pass Tank, Eagle Tank; North Pinta Tank, Buckhorn Tank; Cabeza Prieta Tanks.

TA: Tinajas Altas, *Vorhies 16 Apr 1924*. Tinajas Altas Mts, 9 Mar 1986, *Van Devender 86–12*. †Tinajas Altas, seeds, 5940 ybp.

ACKNOWLEDGEMENTS

We thank Ihsan A. Al-Shehbaz for significant review and information of the mustard family. Mark Dimmitt and Yue Max Li provided review and information for Sahara mustard. Walter Fertig supplied information and scans of specimens at ASU. We thank Susan Davis Carnahan for expert copy editing.

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REDISCOVERY OF *DICHANTHELIUM HIRSTII* (POACEAE) IN GEORGIA

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ABSTRACT

The globally rare grass *Dichanthelium hirstii* was rediscovered in Sumter Co., Georgia, after not being seen for 67 years. Prior to its rediscovery, it was collected in Georgia by Roland Harper in 1900 and Robert Thorne in 1947. Its confirmation as an extant part of the state's flora is documented here and aspects of its biology, as well as the pertinent collection history, are discussed.

In the year 1900, in Sumter Co., Georgia, Roland Harper collected a grass that he labeled simply as "*Panicum*," from a "muddy margin of pine-barren pond" (23 Aug, *458*, NY). Harper later annotated the specimen by writing "*neuranthum* Griseb. (Det. G.V. Nash) [no date]" following "*Panicum*." Forty-seven years after Harper's collection, Robert Thorne collected a grass in Calhoun Co., Georgia, that he labeled as "*affin.* [akin to] *Panicum neuranthum* Griseb.," from a "cypress swamp, 1 mile north of Leary" (31 May, 1947, *4313*, US.). Thorne later annotated the specimen by crossing out his initial determination and writing "*roanokense* Ashe [no date]" above "*neuranthum* Griseb." Thorne did not include *Panicum roanokense* Ashe [= *Dichanthelium dichotomum* var. *roanokense* (Ashe) LeBlond] from Calhoun Co. in his paper on the flora of southwest Georgia (Thorne 1954), nor did he recognize *Panicum neuranthum* Griseb. [= *Dichanthelium neuranthum* (Griseb.) LeBlond].

Eleven years after Thorne's collection in Georgia, in July 1958 in Atlantic Co., New Jersey, the brothers Frank (1928-2009) and Bob Hirst (1925-1963) discovered a "strange looking" (Frank Hirst, pers. comm.) grass growing in a seasonally flooded wetland depression (Walz 2012; CNOR 2014). Frank made a collection of this plant in 1959 and labeled the specimen only as "*Panicum*," from "Leipzig Ave. Pond, Germania" (7 Jun, *47*, US). Unable to apply a species name, the brothers asked Bayard Long, curator of herbarium PH (Academy of Natural Sciences, Philadelphia) for help with identification (Frank Hirst, pers. comm.; Walz 2012). Long recognized that the plant was likely new to science (Frank Hirst, pers. comm.; Walz 2012), so he sent Frank's specimen *47* to J.R. Swallen, a Poaceae expert at herbarium US (National Museum, Smithsonian Institution, Washington, D.C. (Swallen 1961; Walz 2012). Swallen (1961) described the Hirst collection as a new species [*Panicum hirstii* Swallen = *Dichanthelium hirstii* (Swallen) Kartesz] and designated *Hirst 47* as the type. Swallen also examined Harper's specimen *458* and Thorne's specimen *4313* and determined

that these collections were also *Panicum* (*Dichanthelium*) *hirstii* (Swallen 1961). Swallen likely used the singular epithet *hirstii* because only Frank's name was on the label of the type specimen, but the common name, Hirst Brothers' Panic Grass (plural possessive), recognizes both brothers as co-discoverers.

In 1960, the Hirst brothers found a second population of *Dichanthelium hirstii* in New Jersey (Atlantic Co., "pond-bog, sw of Duerer St. and sw of Leipzig Ave., (new location), Germania," 21 Jul 1960, *Hirst 53*, PH), not far from their first collection in 1958 (Walz 2012; CNOR 2014). In 1984, Frank Hirst discovered *D. hirstii* in Sussex Co., Delaware (10 Aug, *110*, DOV), while doing rare plant surveys in seasonally flooded wetland depressions. In 1990, Richard LeBlond discovered *D. hirstii* growing in two sites while doing surveys in pond cypress savanna wetlands on the Camp Lejeune Marine Corps Base in Onslow Co., North Carolina (LeBlond & Sorrie 2001). In July 2004, Russell Juelg and Ted Gordon (Walz 2012; CNOR 2014) discovered a third population of *D. hirstii* for New Jersey in Burlington Co., approximately 29 km (18 mi) north-northwest of the Atlantic Co. site of 1958 (Walz 2012; CNOR 2014).

Dichanthelium hirstii was declared a Candidate species for listing as either Threatened or Endangered by the U.S. Fish & Wildlife Service (Federal Register 1999; CNOR 2014). This status has given incentive for a range-wide status survey of *D. hirstii*, which is ongoing and includes monitoring of existing populations and searches for undocumented populations. Due to the rarity of *D. hirstii* in Georgia, the first author, with funding from the USFWS and assistance from the co-authors, planned and conducted field surveys in Georgia for the species in 2013 and 2014. The objectives were to determine whether suitable habitat still existed for *D. hirstii* and to relocate the historic populations or find previously unknown populations.

METHODS

Surveys targeted potential habitat in southwest Georgia (Baker, Calhoun, Dougherty, Lee, and Sumter cos.) on the Dougherty Plain, a nearly flat sandy plain with limestone near the surface and characterized by karst topography, where numerous sinkholes and wetland depressions have developed (Edwards et al. 2013). Habitat for *Dichanthelium hirstii* in New Jersey, Delaware, and North Carolina are shallow, flat-bottom, wetland depressions that have fluctuating water levels and are not permanently flooded. They are typically flooded during periods of high precipitation and low rates of evapotranspiration, usually in the winter and spring, and dry during periods of low precipitation and high rates of evapotranspiration, usually during the summer months. The length of the hydroperiod is usually dependent on annual weather patterns and groundwater levels. Sites that are open and sunny often support a diverse assemblage of herbaceous plant species. They have been variously described as Coastal Plain seasonal ponds (McAvoy & Bowman 2002), Coastal Plain intermittent ponds (Walz et al. 2006), and Coastal Plain depression communities or pond cypress savannas (Schafale, 2012; Sutter et al. 2014).

In Georgia, we focused on wetland depressions known as lime-sink ponds, which are thought to have originated from dissolution of underlying limestone and subsidence of surface soils and are most prevalent on the karst topography of the Dougherty Plain (Edwards et al. 2013). They are irregular in shape and range from deep, steep sided depressions to large flat basins. Lime-sink ponds in Georgia have the seasonal water regime described above, which is common to all wetland depressions that support *Dichanthelium hirstii*. Potential survey sites were identified through review of aerial photographs, U.S. Geological Service topographic maps, and consultations with knowledgeable individuals. In addition, state rare plant species records (Georgia Dept. of Natural Resources, rare species database 2014) for *Lobelia boykinii* and *Rhexia aristosa*, taxa that are often associated with *D. hirstii* populations in New Jersey, Delaware, and North Carolina, were consulted in

order to identify potential habitat. *Rhexia aristosa* was in fact collected by Harper [specimen *466*, (Harper 1901)] the same day that he collected *D. hirstii* (specimen *458*).

Additionally, Georgia surveys were conducted in areas where Harper and Thorne made their collections in Sumter and Calhoun counties, respectively. Thorne's specimen label was fairly specific as to where he collected the plant ("cypress swamp, 1 mile north of Leary"), but the only locational data that Harper provided on his label was "Sumter Co." In order to narrow our search area within Sumter Co., we consulted Harper's paper on plants he collected in Georgia in the summer of 1900 (Harper 1901). Harper noted (p. 457) that "the afternoon of the 16th [August] found me at Leslie, a small town of about 200 inhabitants, in the pine-barrens of Sumter county, where I spent five weeks. ... From Leslie I made three trips to Americus … on August 20, 27-29. ... The rest of the time I collected within two or three miles of Leslie." On page 474 (Harper 1901), Harper cites a specimen for *Stillingia aquatica* Chapm.: "my no. 460, collected in a pine-barren pond near Leslie, Sumter county, August 23." Comparing these data to Harper's *Dichanthelium hirstii* specimen (Georgia, Sumter Co., "muddy margin of pine-barren pond," 23 Aug 1900, *458*, NY) clearly shows that Harper collected in and around the town of Leslie on 23 August 1900. Harper's specimen *458* was likely not included in his paper (Harper 1901), because it was not identified at the species level. As mentioned above, Harper labeled this specimen as "*Panicum*" but later annotated it as "*neuranthum* Griseb." based on Nash's determination, which was likely sometime after 1901.

RESULTS

Field surveys in 2013 failed to rediscover *Dichanthelium hirstii* in Georgia, although many of the sites visited contained suitable habitat for the species and many of those sites were marked for revisits in 2014. Though we were unsuccessful in finding *D. hirstii* in 2013, we are however confident that we did relocate Thorne's specimen *4313* collection site (Georgia, Calhoun Co., "cypress swamp, 1 mile north of Leary," 31 May, 1947, US). Unfortunately, the canopy at this site is closing in with pond cypress (*Taxodium ascendens*). Though sunny gaps exist, they are likely not large enough to support *D. hirstii*. We did find a few species that were collected by Thorne in 1947 ("1 mile north of Leary," 31 May 1947) and that were cited in his doctoral thesis (Thorne 1949), such as *Rhynchospora filifolia* (*5667*), *Xyris smalliana* (*5665*), and *Stillingia aquatica* (*s.n.*). In addition, we also found *Pieris phillyreifolia* at this site. Thorne did not specifically cite in his thesis that he collected this species "1 mile north of Leary," but he did cite a collection of it (*s.n.*) as being "in shallow water of cypress ponds near Leary" (Patrick 2014).

The last day of planned surveys in 2014, found us exploring the environs near the town of Leslie, in Sumter Co., Georgia, the area where Harper collected *Dichanthelium hirstii* 114 years ago (23 Aug 1900, *458*, NY). We visited several lime-sink ponds that day, all of which appeared to have unsuitable habitat for *D. hirstii*. The August day was quite warm and our energy levels were low, but we were encouraged by the potential of our next pond to visit. Upon entering the open, sunny depression we could tell that this site could be favorable for *D. hirstii*. It did not take long before we found what was clearly a sterile plant of a *Dichanthelium* that had branched stems with stiff, erect-spreading, narrow leaves. We soon found several plants with autumnal flowering, which had the characteristic narrow panicle, appressed erect-ascending pedicels, and glabrous spikelets of *D. hirstii*. With the identification verified, we proceeded to search the pond for additional plants, make habitat notes, and record associated plant species (Appendix). We estimated the population to be about 500 plants, which is exceptional considering that prior to this rediscovery, only 21 plants had been seen in 2014 from all the known populations: 20 in New Jersey (Kathleen Strakosch Walz, pers. comm., 2014) and one in North Carolina (based on field surveys by McAvoy, LeBlond, and others in 2014).

Voucher: **Georgia. Sumter Co.**: Leslie, about 500 plants scattered throughout a seasonally flooded wetland depression, or lime-sink pond, pond dry but saturated to surface, open and sunny, dominated by *Hypericum fasciculatum* and *Rhynchospora careyana*, *D. hirstii* in early autumnal flowering, with 100s of culms, many vernal culms lacking spikelets still persisting, 7 Aug 2014, *W.A. McAvoy 7442* with Tom Patrick (GA).

Associated plants of note at the rediscovery site are *Lobelia boykinii*, *Stillingia aquatica*, *Rhynchospora harperi*, and *Hypericum harperi* (Appendix). *Lobelia boykinii*, which is abundant and widespread throughout the site, is known from all but one population where *Dichanthelium hirstii* is known to occur throughout its range (McAvoy & Wilson 2013). *Stillingia aquatica* was regularly observed at the rediscovery site and was cited by Harper (1901). He collected this species the same day he collected *D. hirstii* (23 Aug, *458*): "Having noticed the extreme lightness of the wood of this species [*Stillingia aquatica*], I made a determination of its specific gravity. The specimen experimented with was a part of my no. 460, collected in a pine-barren pond near Leslie, Sumter County, August 23" (Harper 1901). *Rhynchospora harperi* was found to be frequent and scattered through the rediscovery site, and Harper collected this species (as *R. filifolia* Gray) on 23 Aug 1900 from "wet pine barrens, Sumter Co." (*467*, US). This specimen was annotated as *R. harperi* by Gale in 1941 and cited in her work on *Rhynchospora* sect. *Eurhynchospora* (1944). The type specimen was collected in 1902 (Pulaski Co., Georgia, "wet pine barrens about 3 miles east of Hawkinsville," 26 Jun 1902, *Harper 1377*, US), so the first collection of the species was actually in 1900. *Hypericum harperi* was infrequent and scattered at the rediscovery site. Harper collected *H. harperi* (labeled only as "*Hypericum*") on 9 Oct 1902 from a "pine barren pond near Leslie, Sumter Co." (*1731*, US, NY). On the specimen label, in Harper's hand below "Hypericum," he wrote "(same as 457)." Harper's *458* was of course *D. hirstii*, so Harper's specimen *457* was most likely collected on 23 Aug 1900. Harper's specimen *1731* was annotated as *H. harperi* by John K. Boggan (6/2012) and designated as a syntype.

Also of note, but not found at the rediscovery site is *Limum harperi* Small [*L. sulcatum* var. *harperi* (Small) Rogers], which was also collected by Harper on 23 Aug 1900, just three collections prior to collecting *Dichanthelium hirstii* (*458*). The specimen is labeled as "*Limum*" from a "rather dry pine-barren, (flowers 12 mm wide)," (*455* NY). *Limum harperi* was described as a new species by Small (1903) with Harper's specimen designated as the type. Like *D. hirstii*, *L. harperi* is also a critically imperiled species (NatureServe 2015). *Limum harperi* is known only from Georgia, Alabama, and Florida (Weakley 2012).

CONCLUSIONS

According to Harper's specimen record, he collected three taxa new to science on the same day and year, 23 Aug 1900 — *Limum harperi* (*455*), *Dichanthelium hirstii* (*458*), and *Rhynchospora harperi* (*467*), possibly including a fourth, *Hypericum harperi* (*457*) — a notable achievement, even for Harper's time. Furthermore, it is highly probable that *D. hirstii* (*458*) and *R. harperi* (*467*), and possibly *H. harperi* (*457*), were collected from the same site. The fact that *R. harperi* and *H. harperi* are associates of *D. hirstii* at the site of rediscovery adds weight to this possibility. This observation then begs the question: could the site of rediscovery be the actual site where Harper collected *D. hirstii* 114 years ago? We have clearly ascertained that Harper's area of exploration on 23 Aug 1900 must be near the rediscovery site and that a few of the associated plant species from the rediscovery site were also collected by Harper on that date. Thus, we cannot rule out the possibility that the rediscovery site is Harper's original site, but it can likely never be proven. It would be interesting to track down Harper's specimens *456, 459, 461–465*, and *468* (these collection numbers are not listed in Harper 1901) and compare their determinations with other associated plant taxa (Appendix) from the rediscovery site.

The significance of the Georgia rediscovery of *Dichanthelium hirstii* cannot be overstated and additional surveys in the state are strongly merited. The species is ranked by NatureServe as Critically Imperiled Globally [G1, five or fewer extant populations worldwide (NatureServe 2015)] and is known from four states in the USA: New Jersey, Delaware, North Carolina, and Georgia (NatureServe 2015), and all these states rank the species as S1 [critically imperiled statewide (NatureServe 2015)]. In 2014, *D. hirstii* was observed at only three sites: one in New Jersey, one in North Carolina, and now, one in Georgia (the species was last seen in Delaware in 2013, when 11 individuals were counted). With a population of about 500 plants, this rediscovery has elevated the status of *D. hirstii* in Georgia from an uncertain presence to a significant component of the species distribution.

TAXONOMIC NOTES

Some taxonomic treatments of *Dichanthelium* do not recognize *D. hirstii* at all (Kral 1983; Gleason & Cronquist 1991), even in synonymy (Gould & Clark 1978; Godfrey & Wooten 1979; Freckmann & Lelong 2003). Dr. Alfred E. Schuyler, however, with funding from the USFWS concluded that *D. hirstii* is taxonomically distinct (Schuyler 1996). In addition, Weakley's (2012) treatment of the genus *Dichanthelium*, written by Richard LeBlond, recognizes *D. hirstii* as valid.

Hitchcock and Chase (1910) apparently thought, with uncertainties however, that Harper's specimen *458* should be assigned to *Panicum roanokense* Ashe [= *Dichanthelium dichotomum* (L.) Gould var. *roanokense* (Ashe) LeBlond]. In the description of *P. roanokense* (1910, p. 197), they cited Harper's specimen: "Harper's number 458, from Sumter Co., Georgia, is doubtfully referred to this species [*Panicum roanokense*]. The first glume is very short, the panicle narrow with few, appressed branches, and the blades are long and narrow." Schuyler (1996) pointed out that both *D. hirstii* and *D. dichotomum* var. *roanokense* have glabrous spikelets approaching the same dimensions — equally prominent nerves in the leaves, second glumes, and sterile lemmas — and both have similar hyaline, sterile paleas. However, *D. dichotomum* var. *roanokense* is clearly distinguished from *D. hirstii* by having more branched and reduced axillary shoots, a more open and spreading panicle, with pedicels often twice or more as long as the spikelets, a longer first glume (0.6–1.1 mm vs. 0.3-0.4 mm), and more variation in the number of nerves (7–9) in the second glumes and sterile lemmas. In addition, *D. dichotomum* var. *roanokense* inhabits swales, meadows, swamps and low woods (Schuyler 1996), while *D. hirstii* is found in seasonally flooded wetland depressions.

Dichanthelium hirstii does resemble *D. neuranthum*, explaining why Harper's specimen *458* was determined by Nash as such and why Thorne initially labeled his specimen *4313* as "*affin. Panicum neuranthum* Griseb." The similarities between the two taxa are based primarily on the firm, erect, long, narrow leaf blades and the tightly constricted panicle that both taxa possess (Richard LeBlond, pers. comm.). The most distinguishing characters to separate the two include spikelets of *D. hirstii* glabrous (vs. papillose-pubescent for *D. neuranthum*) and first glume length of *D. hirstii* 0.3-0.4 mm (vs. 0.8-1.0 mm for *D. neuranthum*) (Richard LeBlond, pers. comm.). In addition, habitat preferences are different between the two — *D. hirstii* prefers pond cypress savannas, lime-sink ponds, and seasonally flooded wetland depressions, while *D. neuranthum* prefers moist sandy open ground, maritime grasslands or swales, and wet savannas (Richard LeBlond, pers. comm.).

ACKNOWLEDGEMENTS

We are very grateful to the following individuals who gave their time to help with various aspects of this project: Russell Juelg, Alan Isler, Kay Kirkman, Greg Krakow, Richard LeBlond, Rebecca Pudner, Ernie Schuyler, David Snyder, Hunter Spence, Amanda Treher, and Kathleen Strakosch Walz. Additional assistance following our rediscovery was obtained from Wilson Baker and Richard Carter, and many thanks to Richard Carter for his contributions to the associated plant species list.

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APPENDIX

Vascular plant taxa associated with *Dichanthelium hirstii* that were recorded in a seasonally flooded wetland depression (lime-sink pond) in Sumter Co., Georgia, 7 Aug 2014. For the most part, nomenclature follows Weakley (2012). Frequency of Occurrence criteria: Rare (known from only 1 or 2 small populations), Infrequent (occasionally encountered), Frequent (generally encountered), Common (dominant, abundant, widespread), Locally Common (common, but localized in a particular area of the site, specifically, the lowest point of the pond).

Scientific Name	**Frequency of Occurrence**
Acer rubrum L.	Infrequent
Andropogon perangustatus Nash	Infrequent
Aristida palustris (Chapm.) Vasey	Frequent
Aronia arbutifolia (L.) Pers.	Frequent (pond perimeter)
Carex glaucescens Ell.	Rare
Coelorachis rugosa (Nutt.) Nash	Frequent
Coleataenia longifolia (Torr.) Soreng subsp. *longifolia*	Infrequent
Cyperus erythrorhizos Muhl.	Locally Common
Cyrilla racemiflora L.	Frequent (pond perimeter)
Dichanthelium acuminatum (Sw.) Gould & Clark var. *lindheimeri* (Nash) Gould & Clark	Infrequent
Dichanthelium erectifolium (Nash) Gould & Clark	Rare
Dichanthelium hirstii (Swallen) Kartesz	Common
Dichanthelium longiligulatum (Nash) Freckmann	Rare
Diospyros virginiana L.	Rare
Eragrostis hypnoides (Lam.) B.S.P.	Locally Common
Erianthus giganteus (Walt.) P. Beauv.	Frequent
Eriocaulon compressum Lam.	Common
Fimbristylis autumnalis (L.) Roemer & Schult.	Locally Common
Gratiola ramosa Walt.	Infrequent
Helenium pinnatifidum (Nutt.) Rydb.	Rare
Hypericum fasciculatum Lam.	Common
Hypericum harperi R. Keller	Infrequent
Ilex glabra (L.) Gray	Frequent (pond perimeter)
Ilex myrtifolia Walt.	Frequent
Juncus repens Michx.	Locally Common

Justicia ovata (Walt.) Lindau var. *lanceolata* (Chapm.) R.W. Long	Infrequent
Lachnanthes caroliniana (Lam.) Dandy	Infrequent
Lobelia boykinii Torr. & Gray ex DC.	Frequent
Ludwigia lanceolata Ell.	Frequent
Ludwigia linearis Walt. var. *linearis*	Infrequent
Ludwigia pilosa Walt.	Frequent
Ludwigia sphaerocarpa Ell.	Frequent
Lyonia lucida (Lam.) K. Koch	Frequent (pond perimeter)
Morella cerifera (L.) Small	Frequent (pond perimeter)
Nyssa biflora Walt.	Frequent
Panicum hemitomon Schult.	Infrequent
Paspalum dissectum (L.) L.	Locally Common
Paspalum repens P.J. Bergius	Locally Common
Pinus elliottii Engelm. var. *elliottii*	Infrequent
Pluchea baccharis (P. Miller) Pruski	Infrequent
Proserpinaca pectinata Lam.	Infrequent
Rhynchospora careyana Fern.	Common
Rhynchospora cephalantha Gray var. *cephalantha*	Rare
Rhynchospora filifolia Gray	Infrequent
Rhynchospora harperi Small	Frequent
Rhynchospora tracyi Britt.	Frequent
Sabatia bartramii Wilbur	Rare
Sagittaria graminea Michx.	Infrequent
Sclerolepis uniflora (Walt.) B.S.P.	Infrequent
Smilax walteri Pursh	Frequent (pond perimeter)
Stillingia aquatica Chapm.	Frequent
Vaccinium corymbosum L.	Frequent (pond perimeter)
Woodwardia virginica (L.) Sm.	Rare
Xyris fimbriata Ell.	Frequent

Van Devender, T.R., A.L. Reina-Guerrero, D. Delgado-Zamora, S.D. Carnahan, J.L. Anderson, K. Hansen, J.J. Sánchez-Escalante, and G.M. Ferguson. 2015. Additions to the flora of Sonora, Mexico. II. Phytoneuron 2015-8: 1–6. Published 1 February 2015. ISSN 2153 733X

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ABSTRACT

Twenty-three plant taxa are reported for Sonora, and four for Mexico, for the first time. Specimens, observations, and images are deposited in herbaria and are available in the SEINet and MABA online databases.

In 2010, Molina-Freaner and Van Devender published *Diversidad Biológica de Sonora*, which summarized the state of knowledge of all major plant and animal groups in Sonora, Mexico. In the chapter on vascular plants, Van Devender et al. (2010) included a list of the flora of the state of Sonora as an appendix. Since that time Van Devender and Reina-G. have maintained and updated the state flora list. The Southwest Environmental Information Network (SEINet 2014) is the primary source of herbarium collections from the southwestern USA and northwestern Mexico. Coverage in

Mexico is not as comprehensive because the first SEINet efforts were focused on Arizona collections. Data reported here help to fill this information gap.

The Madrean Archipelago Biodiversity Assessment (MABA) program at Sky Island Alliance was started in 2009. This program documents the distributions of all species of plants and animals in the Sky Island Region, especially in Sonora, Mexico. Information comes from historical sources (herbaria, museums, publications, field notes, etc.) and new field collections, observations, and images. Additional observations to document plants and animals have been made in nine isolated Sky Island mountain ranges and numerous other areas in Sonora.

Here we report 23 new plant taxa for the flora of Sonora. Four species are probably new for Mexico. Additional significances are added to individual accounts. Specimens identified by specialists are acknowledged; others were determined by the collectors. Some of them are from the MABA Expeditions to the Sierras Bacadéhuachi de los Ajos, la Huérfana [=Mazatán], la Púrica, and San Luis, and the Ciénega de Saracachi in Sonora. Others are from floristic inventories of Rancho el Aribabi (Delgado-Z.), Rancho San Bernardino (Delgado-Z.), the municipios of Hermosillo and Yécora (Reina-G., Van Devender), and the Sierra de Mazatán (Sánchez-E.).

All of these biological observations and related images are publicly available in the MABA database (www.madrean.org). The FLORA part of the database is directly linked to SEINet. Most of these range extensions are documented by herbarium specimens, but others are observations and/or photo vouchers in the MABA database or SEINet General Observations. Non-native species are denoted by "*".

SPECIES RECORDS

Ageratina rubricaulis (Kunth) King & H. Rob. (Asteraceae). **Mexico. Sonora.** Mpio. de Bacadéhuachi: Rincón de Guadalupe, 16.5 km (by air) ENE of Bacadéhuachi, Arroyo Campo los Padres (Río Riíto drainage) Sierra de Bacadéhuachi, 29°50'40" N 108°58'37" W, 1690 m, uncommon herbaceous perennial with white flowers in pine-oak forest, 31 Mar 2012, *Reina-G. 2012-275, Van Devender, Rice* (TEX, det. B.L. Turner, 2014).

Artemisia campestris L. (Asteraceae). **Mexico. Sonora.** Mpio. de Agua Prieta: Rancho Los Ojos, El Cajón Bonito, 6.3 km SE of MEX 2 (at 53 km E of Agua Prieta), Cuenca Los Ojos conservation area, 31°16'42" N 109°00'04" W, 1291 m, common herbaceous perennial in understory of cottonwood willow riparian forest, 26 Apr 2009, *Reina-G. 2009-77, Van Devender, Wilder, Kamp, Anderson* (ARIZ, MEXU, TEX); Ánimas Valley, 60.9 km (by air) E of Agua Prieta, Cuenca Los Ojos Foundation property, 31°18'19" N 108°53'14" W, 1610 m, locally very common annual in seasonally-flooded soils in *Nolina* plains grassland, 15 May 2010, *Van Devender 2010-392, Reina-G., Roll, Enderson,* (ARIZ, TEX, USON; all det. B.L. Turner).

Bidens oligantha Brandeg. (Asteraceae). **Mexico. Sonora.** Mpio. de Ímuris: Arroyo las Palomas, Rancho El Aribabi, a 29.3 km (línea recta) ENE de Ímuris, Sierra Azul, 30.81944° N -110.54833° W, 1345 m, 17 Sep 2011, *Delgado-Zamora 2011-261, Parra* (TEX, det. B.L. Turner).

Bidens schaffneri (A. Gray) Sherff **var. wrightii** (A. Gray) Melchert (Asteraceae). **Mexico. Sonora.** Mpio. de Ímuris: Cañón El Cajoncito cerca el Río Cocóspera, Rancho El Aribabi, 17.8 km (linea recta) ENE of Ímuris, 30.83944° N -110.68307° W, 933 m, 29 Oct 2011, *Delgado-Zamora 2011-354, Valdez-Coronel* (TEX, det B.L. Turner).

Significance. Bidens schaffneri var. *wrightii* is named for Charles Wright, botanist on the United States-Mexico boundary survey. He collected *Bidens schaffneri* in Sonora (MO) in 1851-52. After

the Gadsden Purchase in 1853, some of the Sonoran areas where Wright collected became Arizona. This collection verifies its presence in Sonora.

Helianthus quinquenervis Hook. (Asteraceae). **Mexico. Sonora.** Mpio. de Nacozari de García: Antennas on top of Sierra la Púrica, 19.1 km (by air) NNW of Nacozari, Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe, 30°32'39" N 108°54'55" W, 2467 m, locally abundant herbaceous perennial, rays and disks yellow, in pine forest, 17 Jul 2013, *Van Devender 2013-116, Reina-G., Ochoa-Gutiérrez* (TEX); antennas on top of Sierra la Púrica, 19.1 km (by air) NNW of Nacozari, Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe, 30°32'39" N 108°54'55" W, 2467 m, locally common robust herbaceous perennial, rays and disk yellow in pine forest, 9 Sep 2013, *Reina-G. 2013-330, Van Devender, Markgraf, Ávila, Roll, Minter, Deyo* (TEX, USON). All det. B.L. Turner.

Hieracium albiflorum Hook. (Asteraceae). **Mexico. Sonora.** Mpio. de Nacozari de García: Antennas on top of Sierra la Púrica, 19.1 km (by air) NNW of Nacozari, Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe, 30°32'39" N 108°54'55" W, 2467 m, uncommon herbaceous perennial in pine forest, 9 Sep 2013, *Reina-G. 2013-323, Van Devender, Markgraf, Ávila, Roll, Minter, Deyo* (TEX, USON, det. B.L. Turner).

Hymenopappus mexicanus A. Gray (Asteraceae). **Mexico. Sonora.** Mpio de Bacoachi: Sierra de los Ajos, slopes of Cerro de las Flores, 30.93518° N -109.95118° W, 2377 m, growing in open limestone glade, pine-oak-juniper Madrean woodland with *Pinus engelmannii, Quercus arizonica, Juniperus deppeana*, 25 Aug 2014, *Anderson 2014-34* (ASU).

***Sonchus arvensis** L. subsp. **uliginosus** (M. Bieb.) Nyman (Asteraceae). **Mexico. Sonora.** Mpio. de Hermosillo: Old Río Sonora channel, SW side of Hermosillo, gravel quarry, 29°03'43" N 111°01'20" W, 190 m, rare herbaceous perennial, flowers yellow in badly disturbed soil, 11 Feb 2014, *Reina-G. 2014-27, Van Devender* (TEX, det. B.L. Turner).

Significance. First record for Sonora and Mexico.

***Sonchus tenerrimus** L. (Asteraceae). **Mexico. Sonora.** Mpio. de Cucurpe: Ciénega de Saracachi, Rancho Agua Fría, Río Saracachi, 10.6 km (by air) ENE of Cucurpe, 30°21'35" N 110°35'53" W, 945 m, solitary annual, flowers yellow, 28 Apr 2011, *Reina-G. 2011-167, Van Devender, Phillips, Moser, Ochoa-Gutiérrez* (TEX, det. B.L. Turner).

Cerastium fastigiatum Greene (Asteraceae). **Mexico. Sonora.** Mpio. de Bacoachi: Puerto Frijolito, Sierra de los Ajos, 30.5 km (by air) ESE of Cananea, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30.95056° N -109.96333° W, 2289 m, 25 Aug 2014, *Carnahan 764, Hansen* (ARIZ).

Significance. First record for Sonora and probably Mexico.

Nama dichotomum (Ruiz & Pav.) Choisy (Boraginaceae). **Mexico. Sonora.** Mpio. de Cananea: Within 2 km of Ajos Nuevos station, Cañón de Evans, Sierra de los Ajos, 29.9 km (by air) E of Cananea, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30.97283° N -109.96075° W, 1905 m, rocky stream canyon, riparian deciduous forest in canyon, oak woodland and pine-oak forest on slopes, 27 Aug 2014, *Carnahan 805, Hansen* (ARIZ).

Draba helleriana Greene (Brassicaceae). **Mexico. Sonora.** Mpio. de Cananea: 10.9 km (by air) WNW of Cananea, along road to Observatorio Astrofisico Guillermo Haro, Sierra La Mariquita,

31°03'05" N -110°23'06" W, 2445 m, on rock face in pine-oak forest, 4 Aug 2013, *Van Devender 2013-152, Reina-G, Molina* (ARIZ, DES, MEXU, MO, TEX, USON, det. A. Salywon).

Chenopodium hians Standl. (Chenopodiaceae). **Mexico. Sonora.** Mpio. de Agua Prieta: Rancho los Ojos, Cajón Bonito, ca. 49.2 km (by air) ESE of Agua Prieta, 6.3 km SE of MEX 2 (at 53 km E of Agua Prieta), Cuenca Los Ojos Foundation conservation area, 31°16'42" N 109°00'04" W, 1291 m, rare herbaceous perennial in cottonwood-willow riparian forest, 30 Sep 2009, *Reina-G 2009-1763, Van Devender, Schmidt, Turner* (ARIZ, SDSU, det. N. Benet-Pierce).

Significance. First records for Sonora and probably Mexico.

Chenopodium incanum (S. Wats.) A. Heller (Chenopodiaceae). **Mexico. Sonora.** Mpio. de Agua Prieta: Rancho El Valle, southern extension of the Ánimas Valley, 1.6 km S of MEX 2, Cuenca Los Ojos conservation area, ca. 61 km E of Agua Prieta on MEX 2, 31°18'33" N 108°56'08" W, 1616 m, common annual in disturbed soil in Plains grassland, 15 Aug 2007, *Van Devender 2007-747, Reina-G, Enderson* (ARIZ, SDSU, TEX, USON); E of Rancho La Bota, Ánimas Valley, 57.7 km (by air) E of Agua Prieta, Cuenca Los Ojos Foundation property, 31°18'44" N 108°53'52" W, 1609 m, locally common prostrate annual in disturbed soil in plains grassland, 17 May 2010, *Van Devender 2010-494, Reina-G, Roll* (ARIZ, SDSU, TEX, USON). All det. N. Benet-Pierce.

Chenopodium missouriense Aellen (Chenopodiaceae). **Mexico. Sonora.** Mpio. de Yécora: Restaurant La Palmita, 9.5 km W of Restaurant Puerto de la Cruz on MEX 16 (KM 258 E of Cd. Obregón), N side of Mesa del Campanero, 28°22'18"N 109°03'53"W, 1460 m, uncommon annual in oak woodland, 2 Oct 2003, *Reina-G 2003-1158, Van Devender, Dimmitt, Eubanks* (SDSU); MpioYécora, 28°22'30" N 108°56' W, 1540 m, solitary 1.0 m tall annual on roadside near house, 17 Sep 1998, *Reina-G 98-1200, Van Devender, Guerrero-R.* (SDSU, USON). All det. N. Benet-Pierce.

Iris missouriensis Nutt. (Iridaceae). **Mexico. Sonora.** Mpio. de Bacoachi: Arroyo Hoya del Packard, 1.0 km (along old logging road) SW from head of canyon, (0.85 km airline SSE Cerro Pelon), Sierra Los Ajos, Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe, 30.9366° N -109.9644° W, 2250 m, deep soil in limestone near moist streamside, 24 Aug 2014, *Ferguson 3615* (ARIZ); base of Cerro las Flores, 32.9 km (by air) ESE of Cananea, Sierra de los Ajos, 30.9357° N -109.9576° W, 2373 m, 5 Aug 1998, *Schwalbe, Alberti* (MABA observation); Hoya de Packard, S of Cerro Pelón, Sierra de los Ajos, 29.9 km (by air) ESE of Cananea, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30.9256248° N -109.98684° W, 2082 m, rocky mountainside in pine-oak forest, 24 Aug 2014, *Anderson* (MABA observation); Puerto Frijolito, Sierra de los Ajos, 30.5 km (by air) ESE of Cananea, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30.94567° N -109.96175° W, 2336 m, rocky mountainside in pine-oak forest, 25 Aug 2014, *S. Carnahan, K. Hansen* (MABA observation).

Significance. An observation of this species was reported for the Sierra de los Ajos by Fishbein et al (1995). *Ferguson 3615* is the first herbarium specimen for Sonora.

Juncus saximontanus A. Nels. (Juncaceae). **Mexico. Sonora.** Mpio. de Cucurpe: Cañón El Quemado, Arroyo La Palmita, 16.2 km (by air) ENE of Cucurpe, 30°21'51"N 110°32'30"W, 984 m, locally abundant, perennial in cotton-willow riparian forest, mesquite bosque and desert grassland above stream, 29 Apr 2011, *Van Devender 2011-222, Reina-G., Phillips, Moser, Ochoa-Gutiérrez* (ASC, EIU, USON, det. M. Licher & G. Rink).

Monarda fistulosa L. subsp ***menthifolia*** Graham (Lamiaceae). **Mexico. Sonora.** Mpio. de Bacoachi: Sierra de los Ajos, slopes of Cerro de las Flores, 30.93518°N -109.95118°W, 2377 m, pine-

oak-juniper Madrean woodland with *Pinus engelmannii, Quercus arizonica, Juniperus deppeana*, 25 Aug 2014, *Anderson 2014-40* (ASU).

Mirabilis melanotricha (Standl.) Spellenberg (Nyctaginaceae). **Mexico. Sonora.** Mpio. de Bacoachi: Puerto Frijolito, N of Cerro las Flores, Sierra de los Ajos, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30.94567°N -109.96175°W NAD27 , 2316 m, flowers deep pink, sepals washed with purple in pine-oak forest, 25 Aug 2014, *Carnahan 777, Van Devender, Reina-G., Ferguson, Hansen* (ARIZ).

Scoparia montevidensis (Spreng.) R.E. Fries (Plantaginaceae). **Mexico. Sonora.** Mpio. de Ures: Sierra de Mazatán. A 3.75 km (en línea recta) al SE del poblado de Rancho Viejo, sobre el camino que conduce a la cima de la sierra, 29.1119444 -110.278611, 495 m, herbácea anual, flores amarillas, rara creciendo sobre el arroyo en sustrato muy húmedo in matorral espinoso de pie de monte, 16 Mar 2004, *Sánchez-Escalante* 04-063, *Espericueta-Betancourt* (USON, det. J. Boggan).

Significance. First records for Sonora and Mexico.

Bromus mucroglumis Wagon (Poaceae). **Mexico. Sonora.** Mpio. de Cananea: Ajos Nuevos station, Cañón de Evans, Sierra de los Ajos, 29.9 km (by air) E of Cananea, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30°58.37' N -109°57.645° W, 1905 m, 24 Aug 2014, *Reina-G. 2014-402, Van Devender, Jimenez-M.* (ARIZ, det. M. Bauer).

Agrimonia striata Michx. (Rosaceae). **Mexico. Sonora.** Mpio. de Cananea: Ajos Nuevos Station, Ajos-Bavispe Reserve, Sierra de los Ajos, near Cananea, 30.97283° N -109.96075° W NAD27, 1905 m, riparian deciduous forest, 28 August 2014, *Carnahan 810, Hansen, Van Devender, Reina-G., Ferguson,* (ARIZ); Ajos Nuevos station, Cañón de Evans, Sierra de los Ajos, 29.9 km (by air) E of Cananea, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30.97283° N -109.96075° W, 1905 m, rocky stream canyon, riparian deciduous forest in canyon, oak woodland and pine-oak forest on slopes, 24 Aug 2014, *Reina-G. 2014-383, Van Devender, R.E. Jiménez-M.* (ARIZ, ASC, MEXU, USON).

Stenotis greenei (A. Gray) Terrell & H. Rob. (Rubiaceae). **Mexico. Sonora.** Mpio. de Cananea: Within 2 km of Ajos Nuevos station, Cañón de Evans, Sierra de los Ajos, 29.9 km (by air) E of Cananea, Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, 30.97283° N -109.96075° W, 1905 m, rocky stream canyon at riparian deciduous forest in canyon, oak woodland and pine-oak forest on slopes, 27 Aug 2014, *Carnahan 804, Hansen* (ARIZ).

ACKNOWLEDGEMENTS

We thank Sky Island Alliance for supporting biotic inventories in the Madrean Archipelago. The Mexican agencies CONABIO and CONAFOR supported plant inventories on Rancho El Aribabi and in the Sierra de Mazatán, respectively. Mario Cirett, Director of the Ajo-Bavispe CONANP Reserve, greatly facilitated the MABA Expeditions to the Sierra de los Ajos and la Púrica. Carlos Robles-Elías (Rancho El Aribabi), Martín Padrés (Rancho Agua Fría), Valer Austin (Cuenca los Ojos conservation area), and Rubén and Ubelina Coronado (Rancho la Palmita) allowed us to visit their ranches. Rosa E. Jimenez-Maldonado, "Chovy" Francisco Isaías Ochoa-Gutiérrez, Chris Roll, Vera Markgraf, Barbara G. Phillips, and Laura Moser helped in the field. Anderson acknowledges his wife Leanna Anderson for support while he is on MABA field trips. For identifications, we thank Billie L. Turner (Asteraceae), Nuri Benet-Pierce (*Chenopodium*), Max Licher and Glenn Rink (*Juncus*), and Michael Bauer and Gerrit Davidse (Poaceae). Tom Wendt at the University of Texas Herbarium helped with information about Asteraceae collections.

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Loeuille, B. 2015. New combinations and a lectotypification in Brazilian Vernonieae (Asteraceae). Phytoneuron 2015-9: 1–3. Published 12 February 2015. ISSN 2153 733X

NEW COMBINATIONS AND A LECOTYPIFICATION IN BRAZILIAN VERNONIEAE (ASTERACEAE)

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ABSTRACT

Three new nomenclatural combinations are proposed: **Lepidaploa xiquexiquensis** (D.J.N. Hind) Loeuille, **Lessingianthus pottii** (R. Esteves) Loeuille and **Vernonanthura rubriramea** (Mart. ex DC.) Loeuille & P.N. Soares. Additionally, the name *Vernonia rubriramea* Mart. ex DC. is lectotypified.

The polyphyletic nature of *Vernonia* Schreb. sensu lato is now acknowledged from phylogenetic studies (Keeley et al. 2007; Keeley & Robinson 2009; Loeuille et al. 2015) and the genus is actually restricted to 22 species, mostly from eastern North America; only five species occur in Mexico and two in South America (Keeley & Robinson 2009). However, in the course of floristic works and routine identifications in Brazilian herbaria I came upon with some *Vernonia* species which have not yet been transferred to one of the segregate genera in Vernonieae, even though they do not exhibit any diagnostic feature of *Vernonia* sensu stricto. Publishing these combinations allows inclusion of these species in the List of Species of the Brazilian Flora (2015), where they are presently lacking.

Vernonia xiquexiquensis D.J.N. Hind is a perennial herb or subshrub from the sand dunes at margins of the Rio São Francisco near Xique-Xique in Bahia State (Hind 2000). This dune habitat in the semi-arid Caatinga Domain is rich in plant endemism (Rocha et al. 2004). As stated by the author of the taxon, the species displays the following characters typical of *Lepidaploa* (Cass.) Cass.: non-glandular anther appendages, basal style node, and tricolporate, echinolophate pollen grains with poral lacunae prominent (type C) (Robinson 1990; Hind 2000). I propose the following new combination.

LEPIDAPLOA XIQUEXIQUENSIS (D.J.N. Hind) Loeuille, **comb. nov.** Basyonym: *Vernonia xiquexiquensis* D.J.N. Hind, Kew Bull. 55: 182. 2000. **TYPE. BRAZIL. BAHIA:** Mun. Xique-Xique, dunas do Rio São Francisco, 548 m alt., 23 Jun 1996, *A.M. Giulietti et al. 29280* (holotype: ALCB; isotypes: HUEFS, K).

Vernonia pottii R. Esteves is a subshrub endemic from western Brazilian Pantanal, a large wetland plain extending along the western boarder of the Cerrado Domain (Hueck 1972). Several features of this species, such as non-glandular anther appendages, lack of basal style node, and tricolporate, echinolophate pollen grains with irregular areoles and colpi lacking polar lacunae (type B) (Esteves et al. 2005) clearly relate the species to *Lessingianthus* H. Rob. (Robinson 1988; Angulo & Dematteis 2010). I propose the following new combination.

LESSINGIANTHUS POTTII (R. Esteves) Loeuille, **comb. nov.** Basyonym: *Vernonia pottii* R. Esteves, Bradea 11: 19. 2005. **TYPE. BRAZIL. MATO GROSSO DO SUL:** Mun. Corumbá, Reserva Acurizal, Serra do Amolar, borda oeste do Pantanal, 17°51'38" S, 57°33'12" W, 200 m alt., 7 May 2003, *A. Pott & V.J. Pott 11026* (holotype: HMS !; isotypes: HB, HRJ).

Robinson (1999) noted that *Vernonia rubriramea* Mart. ex DC. belongs to *Vernonanthura* H. Rob. but he did not provide a combination in that genus, perhaps suspecting that it would be a

synonym of *Vernonanthura membranacea* (Gardner) H. Rob. (Almeida et al. 2005). Nonetheless, *V. rubriramea* differs from *V. membranacea* by its more congested panicles, capitula with outer phyllaries squarrose, stramineous and obtuse apices (vs. adpressed, rarely slightly squarrose, chestnut to purple and acute apices), and non-glandular cypselae (vs. glandular) (Soares 2012). *Vernonia rubriramea* is a shrub or treelet from Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Tocantins, and São Paulo states (Hattori & Nakajima 2008; Medeiros et al. 2012). Candolle used one of the specimens housed at M to describe the species, as noted in the protologue: "v.s. in h. Acad. reg. Monac." (Candolle 1836). The fragmentary material at G-DC (barcode G00327449) probably originates from M material but it lacks an original Martius label with locality description; therefore I here designate one of the sheets housed at M as lectotype. The two Martius sheets at M (barcodes M-0029398 and M-0029399) are very similar (quality of specimen, label information) and I chose as lectotype the one (M-0029398) which is labeled as "holotype." The following new combination is proposed.

VERNONANTHURA RUBRIRAMEA (Mart. ex DC.) Loeuille & P.N. Soares, **comb. nov.** Basyonym: *Vernonia rubriramea* Mart. ex DC., Prodr. 5: 38. 1836. **TYPE. BRAZIL.** Habitat in campis prope Gongonhas de Sabará, Provinciae Minas Geraës, *M. von Martius 1158 (27)* (lectotype, here designed: M [scan seen] [barcode no. M-0029398]; isolectotypes: G-DC [scan seen] [barcode no. G00327449] [fragments], M [scan seen] [barcode no. M-0029399], P [scan seen] [barcode no. P00682921] [fragments]).

ACKNOWLEDGEMENTS

I would like to thank José Rubens Pirani and Jimi Naoki Nakajima for their suggestions on the manuscript.

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A MULTIVARIATE MORPHOMETRIC STUDY OF THE *SOLIDAGO ALTISSIMA* COMPLEX AND *S. CANADENSIS* (ASTERACEAE: ASTEREAE)

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ABSTRACT

The *Solidago altissima* complex stretches across much of North America on the prairies and in the eastern deciduous forest. A multivariate morphometric analysis including 28 vegetative and floral traits scored on 162 specimens was performed to assess the classification of the complex in eastern North America proposed by Semple (2014). Discriminant analysis indicated support for recognizing the following taxa: *Solidago altiplanities*, *Solidago altissima* vars. *altissima*, *gilvocanescens*, and *pluricephala*, *S. canadensis* vars. *canadensis* and *hargeri*, and *S. juliae*. A lectotype is designated for *Solidago pruinosa* Greene, which is a synonym of *S. altissima* var. *gilvocanescens*.

The *Solidago altissima* L. complex is part of *Solidago* subsect. *Triplinerviae* (Torr. & A. Gray) G.L. Nesom, which includes 17-18 species (Semple 2014, Asteraeae Lab web site, continuously updated). *Solidago altissima* (Sp. Pl. 878. 1753) occurs across much of central and eastern North America on the prairies and in disturbed habitats of the eastern deciduous forest (Semple & Cook 2006). Typical *S. altissima* (var./subsp. *altissima*; Fig. 1) occurs from the eastern limits of the Great Plains to the Atlantic coast and has been treated as *S. scabra* Muhl. ex Willd. (Sp. Pl. 3. 2059. 1803) and *S. canadensis* var. *scabra* (Muhl. ex Willd.) Torr. & Gray (Fl. N. Amer. 2: 224. 1842). Use of the latter combination in *S. canadensis* is responsible for much of the ambiguity in the literature about the distribution of *S. canadensis* in Asia, particularly when only the species name is listed. The Great Plains race of the species (Fig. 2) was first described as *S. canadensis* var. *gilvocanescens* Rydb. (Contr. U.S. Nat. Herb. 3: 162. 1895) and subsequently treated as *S. gilvocanescens* (Rydb.) Smyth (Trans. Kansas Acad. Sci. 16: 161. 1899), *Doria gilvocanescens* (Rydb.) Lunell (Amer. Midl. Nat. 5: 43. 1917), *S. canadensis* subsp. *gilvocanescens* (Rydb.) Löve & Löve (Taxon 31: 358. 1982), *S. altissima* var. *gilvocanscens* (Rydb.) Semple (Phytologia 58: 430. 1985), and most recently as *S. altissima* subsp. *gilvocanescens* (Rydb.) Semple (Sida 20: 1606. 2003). The name *S. altissima* var. *pluricephala* M.C. Johnston (Southw. Naturalist 14: 372. 1970) was based on specimens collected near Brownsville, Texas, but the name was not widely adopted (Fig. 3). Two species in the complex were described relatively recently: *Solidago altiplanities* Taylor & Taylor (Sida 10: 178. 1983) is a narrow-leaved species native to a limited area on the Texas Panhandle and adjacent Oklahoma (Fig. 4); *Solidago juliae* G.L. Nesom (Phytologia 67: 445. 1989) is a more densely hairy species native to parts of the Edwards Plateau in Texas and scattered locations to the west and southwest in Mexico and in isolated mountains in southeastern Arizona (Fig. 5). *Solidago canadensis* var. *hargeri* Fern. can be difficult to distinguish from members of the *S. altissima* complex but usually has more obviously serrate and sometimes narrower upper stem and lower inflorescence leaves.

Taxonomic treatments of the complex have differed greatly in how many taxa were recognized and at what taxonomic rank. Fernald (1915) described a hairy-stemmed, more southern race of *Solidago canadensis* as *S. canadensis* var. *hargeri* Fern. Fernald (1950) treated *S. altissima* as a separate species but included var. *gilvocanescens* in *S. canadensis*. Cronquist (1968) treated *S. canadensis* and *S. altissima* as separate species but did not divide *S. altissima* into varieties and stated its range to be from Québec to Florida west to North Dakota and Arizona; he treated var. *gilvocanescens* as the separate species using the synonym *Solidago pruinosa* Greene [Pittonia 4: 70. 1899. LECTOTYPE, designated here: **CANADA. Saskatchewan**. Moose Jaw, Assiniboia, 13 Aug 1895, *Macoun 10894* (CAN!); *Macoun 10893* (CAN!) was collected at the same locality]. Scoggan (1979) included typical *S. altissima* in *S. canadensis* as var. *scabra* and the prairie race as var. *gilvocanescens*; he also included *S. lepida* var. *salebrosa* (Piper) Semple as a variety of *S. canadensis*. Melville and Morton (1982) presented a multivariate study of the some of the taxa of the complex plus *S. lepida*, focusing primarily on those occurring in Ontario. They found support for recognizing the two varieties of *S. canadensis*, *S. altissima* at specific rank, *S. lepida* and *S. gigantea*. In the Flora of North America treatment, Semple and Cook (2006) followed Melville and Morton on *S. canadensis*. In a multivariate analysis of the *S. canadensis*/*S.lepida* complex, Semple et al. (2013) dealt with the varieties in *S. canadensis* but not those within *S. altissima*. *Solidago altiplanities* and *S. juliae* of subsect. *Triplinerviae* have been included in the informal *Tortifolia* Group (Semple 2014, Astereae Lab web site, continuously updated) and are included in the multivariate analysis presented here. Additional multivariate morphometric studies in preparation by the Astereae Lab will cover taxa not included here or in Semple et al. (2013). Lopez Laphitz (2009) included *S. juliae* and putatively closely related North American relatives *S. tortifolia* Ell. and *S. leavenworthii* Torr. & A. Gray in her multivariate analysis of South American members of subsect. *Triplinerviae*. A manuscript presenting this M.Sc. research is submitted and under review.

The systematics of the *Solidago altissima* complex is made more difficult due to multiple ploidy levels occurring in the races of *S. altissima*. Only diploids ($2n = 18$) are known in *S. canadensis*, *S. juliae*, and *S. altiplanities* (Nesom 1989; Turner & Zhao 1992; Semple & Cook 2006; Semple et al. 2013). However, sample sizes for the latter two species are small. The cytogeographic pattern in *S. altissima* was discussed in Semple et al. (1984) in regards to var. *gilvocanescens* and var. *altissima*, while var. *pluricephala* was not considered as a separate taxon at that time. Based on all published and some unpublished counts, var. *gilvocanescens* includes diploids and tetraploids ($2n = 36$) with a few hexaploids ($2n = 54$) in the southwestern part of the range. The more eastern and northern var. *altissima* and the more southern var. *pluricephala* include a few tetraploids in the southwestern and southern portions of the ranges, respectively, and hexaploids are dominant (or exclusively) over the entire ranges. A manuscript on the cytogeography of *S. altissima* is in preparation and will include a large number of chromosome counts by the late John K. Morton and a summary of all published counts.

The purpose of this study is to compare specimens of *Solidago altissima* with specimens of morphologically similar (stems densely short hairy proximally to distally) and putatively closely related species and with *S. canadensis*, which includes specimens (stems densely short hairy proximally to distally) often confused with *S. altissima* as well as specimens that are less likely to be confused (stems densely short hairy only distally; stems glabrous/glabrate proximally). Within *S. altissima*, specimens of three named races and a putative fourth race are compared. Field observations on *S. altissima* were made over more than 40 years of field work by J.C.S. including detailed observations on inflorescence shape variation in the southeastern USA in 2006. The field data suggested that there is a generally unrecognized southeastern USA race within *S. altissima*. While analyzing specimens of *S. lepida* and *S. canadensis* for Semple et al. (2013), a number of collections from Saskatchewan and Manitoba were encountered that did not appear to fit well into *S.*

lepida, *S. canadensis*, or *S. altissima*, although a number of them were closest in appearance to var. *gilvocanescens*. Seven of these specimens are included in the analyses below.

The *Solidago lepida* complex includes *S. brendiae* Semple, *S. elongata* Nutt., and *S. fallax* (Fern.) Semple with two varieties, var. *fallax* and var. *molina* (Fern.) Semple, and is defined by the usually leafy inflorescence with usually ascending short branches. Lower stems tend to be sparsely hairy to hairless regardless of how hairy is the upper stem. In the *S. altissima* group, the inflorescences have spreading to arching lower branches, regardless of branch length, and have lower stems that are usually densely short hairy, even if the hairs are sometimes lost as lower stems age and increase in diameter. Individuals of *S. canadensis* range from *S. lepida*-like in stem features to *S. altissima*-like in stem features and have spreading, arching, usually long lower branches. Upper stem and inflorescence leaves tend to have few or no serrations in the *S. altissima* complex, while those of the *S. lepida*/*S. canadensis* complex often have large serrations on upper stem leaves but are sometimes toothless. Semple (2014) placed *S. canadensis* in the informal *Canadensae* group and *S. altissima* in the informal *Tortifoliae* group. Anyone who has made multiple collections of *S. canadensis* will understand that identification of some individuals can be difficult due to similarities with *S. altissima* individuals in some cases and to similarities with *S. brendiae* and *S. fallax* in other cases. Thus, *S. canadensis* is included in this analysis as well, as it was previously in Semple et al. 2013. Analyses to date of the entire *Triplinerviae* subsection suffer from needing too many different characters to define 17-18 species level a priori groups, leaving too few traits for inclusion in the analyses. Subdividing the subsection into more manageable species groups is one solution to this problem. Morphology alone may not be sufficient to determine the true limits of these subgroups. The subgroups are logical but not necessarily phylogenetically correct because inflorescence branching characteristics and variation in stem pubescence may not be phylogenetic markers. Molecular data is needed to provide guidance.

MATERIALS AND METHODS

In total, 168 specimens from BOON, BRIT, JKM (John Morton's personal herbarium) in ROM, and WAT (Thiers, continuously updated) were selected for inclusion in the analysis of the *Solidago altissima*/*S. canadensis* complex from an unpublished matrix of 562 plants covering all taxa in subsect. *Triplinerviae*. For each specimen, 14 vegetative and 16 floral traits were scored: 1-5 replicates per character depending upon availability of material and whether or not the trait was meristic (Table 1). Mean values were used in the analyses, while raw values were used to generate ranges of variation for each trait. Sample sizes varied among taxa based on the size of the range of distribution and availability of specimens: 9 *S. altiplanities,* 88 *S. altissima* (31 *var. altissima,* 29 *var. gilvocanescens,* 28 var. *pluricephala,* 7 putative var. nov.), 53 *S. canadensis* (32 var. *canadensis,* 21 var. *hargeri*), and 11 *S. juliae*.

Traits used to define a priori groups were not included in the analyses to avoid circular logic. Differences in general inflorescence shape and branching characteristics, lower stem pubescence density, and leaf pubescence density were used to define a priori groups along with geographic location. Lower stem leaf traits were not included in the analyses because these were often not present on specimens.

All analyses were performed using SYSTAT v.10 (SPSS 2000). A pair-wise Pearson correlation matrix was created to determine which characters were highly correlated. One trait of each pair that had a $> |0.7|$ correlation value was excluded from the analysis to avoid possible pleiotropic effects of a single gene and to make the tests of null hypotheses more stringent. Stepwise discriminant analysis (STEPDISC) was used to select traits that best separated groups based on the Mahalanobis distances between a priori group centroids. Classificatory discriminant analysis was run on N-1 traits selected by the STEPDISC analysis, if more than N-1 traits were selected, where N =

Table 1. All characters scored on specimens included in the study *S. altissima/S. canadensis* complex; traits scored in replicates of five when material available; 1 value for meristic traits.

STMHT	Height of the stem from base to the top of the inflorescence (cm)
LLFN	Lower stem leaf length (mm)
LLFW	Lower stem leaf length (mm)
LLFWTOE	Length of lower stem leaf from widest point to tip (mm)
LLFSERNUM	Number of serrations on one side of a lower stem leaf (side with the most)
MLFLN	Mid stem leaf length (mm)
MLFW	Mid stem leaf width (mm)
MLFWTOE	Length of mid stem leaf from widest point to tip (mm)
MLFSERNUM	Number of serrations on one side of a mid stem leaf (side with the most)
ULFLN	Upper stem leaf length (mm)
ULFW	Upper stem leaf width (mm)
ULFWTOE	Length of upper stem leaf from widest point to tip (mm)
ULFSERNUM	Number of serrations on one side of a upper stem leaf (side with the most)
CAPL	Length of inflorescence from tip to base of lowest branch (cm)
CAPW	Width of pressed and dried inflorescence at widest point (cm
INVOLHT	Height of involucre from base to tip of longest phyllary (mm)
OPHYLL	Length of outer phyllary (mm)
IPHYLL	Length of inner phyllary (mm)
RAYNUM	Number of ray florets
RSTRAPL	Length of the ray strap (lamina; mm)
RSTRAPW	Width of the ray strap (lamina; mm)
RACHBL	Length of the ray floret ovary at anthesis (mm)
RPAPL	Length of the ray floret pappus at anthesis (mm)
DISCNUM	Number of disc florets
DCORL	Length of the disc floret corolla in total (mm)
DLOBL	Length of the disc floret lobes (mm)
DACHBL	Length of the ray floret ovary at anthesis (mm)
DPAPL	Length of the ray floret pappus at anthesis (mm)

lowest sample size of the a priori groups; in this study N = 7 (when "var. nov." was included as an a priori group) and N=9 (when *Solidago altiplanities* was included as an a priori group). Geisser probabilities of assignment to each a priori group were generated for each specimen a posteriori based on the Mahalanobis distances from the specimen location plotted in N-dimensional hyperspace to each a priori group centroid. Linear and Jackknifed analyses were run in each classificatory analysis to test the strength of group separation in terms of the numbers of discriminating traits. Results are presented in the form of (1) F-value matrices based on Mahalanobis distances between group centroids and (2) tables summarizing the results of the two methods of doing the classificatory discriminant analyses. Conclusions were reached based on the percents of correct placements of specimens and the probabilities of the placements being correct and visual re-examination of each specimen via high resolution digital images. Lastly, a canonical analysis was performed as a dimension reduction technique to allow visualization of results in 1 to 3 dimensions with the number of dimensions being N-1, where in this case N equals the number of a priori groups in an analysis. While canonical analysis allows for a visual presentation of results, the plots are based on fewer axes

than are used in the statistical analyses and thus do not fully show the multi-dimensional nature of the separation of a priori groups.

Assignment to a priori groups was based on the following traits. All specimens of *Solidago altissima* have upper most stem leaves that were usually not obviously serrate and had abaxial main veins that were moderately to densely pubescent and whitish; var. *altissima* has inflorescence arrays that were less than 1.25 times as long as wide and often wider than long, upper stem leaves were entire or had only a few very small serrations; var. *gilvocanescens* has inflorescence arrays like var. *altissima*, usually has grayer looking leaves than the other varieties and upper stem leaves that were sometimes serrate; and var. *pluricephala* usually has inflorescence arrays that are 1.5 or more times as long as wide and are restricted to the southeastern USA from North Carolina to Arkansas and southward to central Florida and south Texas. All specimens of *S. canadensis* have obviously serrate upper stem and inflorescence leaves that have darker green adaxial surfaces and the abaxial veins are sparsely pubescence and green; var. *canadensis* has lower to mid stems that are glabrous proximally to sparsely pubescent distally, while var. *hargeri* has stems hairy to the base. All specimens of *S. juliae* have grayish stems and leaves due to the high density of short white hairs, elongated inflorescence arrays, linear lanceolate upper stem leaves with fine serrations, and were restricted to southwestern Texas and further west. *Solidago altiplanities* is similar in inflorescence traits and leaf shape to *S. juliae* but has more greenish leaves due to lower hair densities and sometimes obscurely trinervate upper stem leaves. Inflorescence traits and leaf serration traits were not used in the discriminant analyses.

Five separate discriminant analyses were performed and are reported here. The first was performed on four species-level a priori groups and included 161 specimens assigned to one of the a priori groups: 9 specimens of *Solidago altiplanities*, 88 specimens of *S. altissima*, 53 specimens of *S. canadensis*, and 11 specimens of *S. juliae*. A second analysis was performed on 6 variety/species-level a priori groups of 161 specimens: 9 specimens of *S. altiplantes*, 31 specimens of *S. altissima* var. *altissima*, 29 specimens of S. *altissima* var. *gilvocanescens*, 28 specimens of *S. altissima* var. *pluricephala*, 32 specimens of *S. canadensis* var. *canadensis*, and 21 specimens of *S. canadensis* var. *hargeri*. A third analysis was performed on four putative variety-level a priori groups of just 88 specimens of *S. altissima*: 31 specimens of var. *altissima*, 29 specimens of var. *gilvocanescens*, 28 specimens of var. *pluricephala*, and 7 specimens of putative "var. nov." A fourth analysis was performed on 3 putative variety-level a priori groups of 81 specimens of *S. altissima* plus 7 specimens assigned a posteriori to the 3 a priori groups: 31 specimens of var. *altissima*, 29 specimens of var. *gilvocanescens*, 28 specimens of var. *pluricephala*, and 7 unassigned specimens of the northern putative "var. nov." A fifth analysis was performed on specimens of *S. altissima* var. *gilvocanescens*, *S. canadensis* var. *canadensis*, and *S. canadensis* var. *hargeri* in order to determine which traits best separate these three races and to what degree.

RESULTS

The means of means for all traits included in the analyses for all taxa are listed in Table 2 (below Literature Cited).

Four species level analysis

Data on all specimens were used to generate a Pearson Correlation Matrix. The following pairs of traits had correlations greater than |0.7|: CAPL–CAPW, INVOLHT–RPAPL, INVOLHT–DCORL, RSTRAPL–RPAPL, RSTRAPL–DCORL, and RPAPL–DCORL. RPAPL and DCORL were excluded in the discriminant analyses. MLFSERNUM and UPLFSERNUM were excluded from the analyses because they were used in defining a priori groups. CAPL and CAPW were also excluded as these were used to partially define a priori groups. Stepwise discriminant analysis selected the following eight traits as useful in separating the four a priori groups in the analysis in

order of decreasing F-to-remove values (in parentheses): INVOLHT (59.31), DLOBL (47.84), DISCNUM (34.14), ULFW (29.87), ULFLN (16.70), RAYNUM (11.26), RACHBL (6.09), and MLFW (5.99). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 3. F-values indicate the largest separation was between *Solidago canadensis* and *S. juliae* and second largest between *S. altissima* and *S. juliae*. The smallest separation was between *S. altissima* and *S. canadensis*.

Table. 3. Between Group F-matrix for the four species-level taxa analysis in the *S. altissima* complex.

	altiplanities	***altissima***	***canadensis***	***juliae***
altiplanities	0.000			
altissima	29.169	0.000		
canadensis	38.601	24.425	0.000	
juliae	63.511	112.419	128.119	0.000

Wilks' lambda = 0.0116 df = 11, 3, 157; approx. F= 46.3832, df = 33, 433; prob = 0.0000

In the Classificatory Discriminant Analysis, correct assignments of specimens for taxa ranged from 87% to 100%. The Classification matrix and Jackknife classification matrix are presented in Table 4. Results for individual a priori taxa are presented in decreasing order of percent correct placement. (1) All 11 specimens (100%) assigned a priori to *Solidago juliae* were placed a posteriori in *S. juliae* with all 11 placed with 100% probability. (2) All 9 specimens (100%) assigned a priori to *S. altiplanities* were placed a posteriori into *S. altiplanities* with 8 placed with 100% probability and 1 with 87% probability. (3) 80 of the 88 specimens (91%) assigned a priori to *S. altissima* were placed a posteriori into *S. altissima*, 64 with 95-100% probability, 3 specimens with 90-94% probability, 3 with 70-89% probability, and 3 with 52-58% proability. Of the 8 specimens not placed in *S. altissima*, 7 were placed in *S. canadensis* with 55-95% probabilities, and 1 was placed in *S. altiplanities* with 85% probability. (4) 46 of the 63 specimens (87%) assigned a priori to *S.*

Table 4. Results of the Classificatory Discriminant Analysis of the four species-level groups of the *S. altissima*/*S. canadensis* complex.

Classification matrix (a priori groups in left column, a posteriori assignments in rows)

	altiplanities	***altissima***	***canadensis***	***juliae***	**% correct**
altiplanities	9	0	0	0	100
altissima	1	80	7	0	91
canadensis	0	7	46	0	87
juliae	0	0	0	11	100
Totals	10	87	53	11	91

Jackknifed classification matrix

	altiplanities	***altissima***	***canadensis***	***juliae***	**% correct**
altiplanities	8	1	0	0	89
altissima	1	78	9	0	89
canadensis	0	8	45	0	85
juliae	0	0	0	11	100
Total	9	87	54	11	88

canadensis were placed a posteriori in *S. canadensis*; 39 specimens with 95-100% probability, 4 specimens with 90-94% probability, and 3 specimens with 52-86% probabilities. All 7 specimens not placed in *S. canadensis* were placed in *S. altissima* with 54-100%.

In the Jackknifed Classificatory Discriminant Analysis, correct assignments did not change or changed little from the linear Classificatory Discriminant Analysis. The largest decrease was for *Solidago altiplanities*, dropping from 100% to 89% correct placement a posteriori, but this was due to only 1 specimen being assigned differently.

Seven specimens not assigned to an a priori group were assign a posteriori to *Solidago* altissima with 97-100% probability. These were the putative "var. nov." specimens of *S. altissima*.

The results of the canonical analysis are shown in Figure 7. Eigenvalues for first three canonical axes were 9.789, 2.600, and 1.214. *Solidago juliae* and *S. altiplanities* are separated from *S. altissima* and *S. canadensis* on the first two axes, while *S. altissima* and *S. canadensis* tend to be separated on the third axis.

Table. 5. Between Group F-matrix for the six variety/species-level taxa analysis in the *S. altissima/ S.canadensis* complex.

	altiplanities	**var. *altissima***	**var. *canadensis***	**var. *gilvocanescens***	**var. *hargeri***	**var. *pluricephala***
altiplanities	0.000					
var. *altissima*	48.265	0.000				
var. *canadensis*	59.744	34.963	0.000			
var. *gilvocanescens*	40.785	9.557	18.863	0.000		
var. *hargeri*	58.631	18.596	12.653	10.281	0.000	
var. *pluricephala*	41.039	3.005	42.942	9.610	20.826	0.000

Wilks' lambda = 0.0485, df = 6 5 144; approx. F = 21.0315 df = 30 558; prob = 0.0000

Six variety/species level taxa analysis

Data on the 150 specimens of *Solidago altiplanities*, *S. altissima* (3 varieties) and *S. canadensis* (2 varieties) were used to generate a pair-wise Pearson Correlation Matrix. The following pairs of traits had correlations greater than |0.7|: CAPL–CAPW, INVOLHT-RPAPL, INVOLHT-DCORL, RSTRAPL-RPAPL, RSTRAPL-DCORL, RPAPL–DCORL, and RPAPL–DPAPL. RPAPL, DCORL and DPAPL were excluded in the discriminant analyses. MLFLN, MLFW, ULFLN, ULFW, INVOLHT, RAYNUM, RSTRAPL, RSTRAPWD, RACHBL, DISCNUM, DLOBL, and DACHBL were included in the STEPWISE analysis. MLFSERNUM and UPLFSERNUM were excluded from the analyses because they were used in defining a priori groups. CAPL and CAPW were also excluded as these were used to partially define a priori groups. Stepwise discriminant analysis selected the following six traits as useful in separating the a priori groups in the analysis including all taxa in decreasing order of F-to-remove value: INVOLHT (50.25), DISCNUM (19.48), MLFW (12.83), RAYNUM (9.18), RSTRAPWD (8.43), and MLFLN (4.85). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 5. F-values indicate the largest separation was between *S. altiplanities*

and the two varieties of *S. canadensis*. The smallest separation was between *S. altissima* var. *altissima* and *S. altissima* var. *pluricephala*.

In the Classificatory Discriminant Analysis, the percents of correct a posteriori assignments of specimens to a priori groups ranged from 55-100% with a mean value of 73% (Table 6). Results for individual a priori taxa are presented in decreasing order of percent correct placement. 1) All nine specimens of *Solidago altiplanities* were assigned a posteriori to *S. altiplanities* with 99-100% probability. 2) 31 of 32 specimens (97%) of *S. canadensis* var. *canadensis* were assigned a posteriori to var. *canadensis*: 15 specimens with 90-100% probability, 9 specimens with 70-89% probability, 5 specimens with 50-69% probability, and 1 with 45% probability. One specimen of var. *canadensis* was assigned a posteriori to var. *altissima* with 43% probability. 3) 24 specimens (83%) of var. *gilvocanescens* were assigned a posteriori to var. *gilvocanescens*: 5 with 80-100% probability, 8 with 60-79% probability, 2 with 50-59% probability, 6 with 40-49% probability, and 2 with 32-33% probability. Five specimens of var. *gilvocanescens* were assigned a posteriori to other taxa: two specimens to var. *canadensis* with 42% and 47% probabilities, two specimens to var. *pluricephala* with 39% and 71% probability, and one to var. *hargeri* with 53% probability. 4) Twelve specimens

Table 6. Results of the Classificatory Discriminant Analysis of the four species-level groups of the *S. altissima* complex.

Classification matrix (a priori groups in left column, a posteriori assignments in rows)

	altiplanities	var. ***altissima***	var. ***canadensis***	var. ***gilvocanescens***	var. ***hargeri***	var. ***pluricephala***	**% correct**
altiplanities	9	0	0	0	0	0	**100**
var. *altissima*	0	17	0	5	1	8	**55**
var. *canadensis*	0	1	31	0	0	0	**97**
var. *gilvocanescens*	0	0	2	24	1	2	**83**
var. *hargeri*	0	1	3	4	12	1	**57**
var. *pluricephala*	1	10	0	1	0	16	**57**
Totals	10	29	36	34	14	27	**73**

Jackknifed classification matrix

	altiplanities	var. ***altissima***	var. ***canadensis***	var. ***gilvocanescens***	var. ***hargeri***	var. ***pluricephala***	**% correct**
altiplanities	9	0	0	0	0	0	**100**
var. *altissima*	0	15	0	5	1	10	**48**
var. *canadensis*	0	2	30	0	0	0	**94**
var. *gilvocanescens*	0	1	3	21	1	3	**72**
var. *hargeri*	0	1	3	4	12	1	**57**
var. *pluricephala*	1	11	0	1	0	15	**54**
Totals	10	30	54	11	14	29	**68**

(57%) of var. *hargeri* were assigned a posteriori to var. *hargeri*: eight specimens with 80-100% probability, three specimens with 6079% probability; one with 54% probability. Nine specimens of var. *hargeri* with assigned a posteriori to other taxa: four were assigned to var. *gilvocanescens* with 42-69% probability, three to var. *canadensis* with 43-83% probability, one to var. *altissima* with 77% probability, and one to var. *pluricephala* with 39% probability. 5) Sixteen specimens of var. *pluricephala* were assigned a posteriori to var. *pluricephala*: six with 82-91% probability, five with 62-78% probability, four with 52-56% probability, and one with 37% probability. Twelve specimens (57%) of var. *pluricephala* were assigned a posteriori to other taxa: 10 were assigned to var. *altissima* with 43-72% probability, one to *S. altiplanities* with 95% probability, and one to var. *gilvocanescens* with 54% probability.

Two dimensional plots of scores of CAN1 versus CAN 2 and CAN1 versus CAN3 of *S. aliplanities, S. altissima* (three separate varieties) and *S. canadensis* (two varieties) is shown in Fig. 8. Eigenvalues for first three canonical axes were 3.115, 1.905, and 0.397. *Solidago altiplanities* is separated from other taxa on the first and second axes. Symbols for varieties of *S. altissima* are generally more central and those for varieties of *S. canadensis* are placed more to the right in both plots.

Four varietal taxa analysis of *S. altissima*

Data on the 95 specimens of *Solidago altissima* were used to generate a pair-wise Pearson Correlation Matrix. No pairs of traits had correlations greater than |0.7|: CAPL and CAPW were excluded as these were used to partially define a priori groups. Stepwise discriminant analysis selected the following four traits in decreasing order of F-to-remove value as useful in separating the a priori groups in the analysis: DCORL (17.44), MLFW (11.58), RAYNUM (7.11), and MLFLN (3.99). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all three groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 7. The largest F-value to separate was between var. *gilvocanescens* and var. *pluricephala*. The smallest F-value to separate was between var. *altissima* and var. *pluricephala*.

Table. 7. Between Group F-matrix for the four variety-level taxa analysis in *S. altissima*.

	altissima	***gilvocanescens***	***pluricephala***	**var. *nov.***
altissima	0.000			
gilvocanescens	8.496	0.000		
pluricephala	5.420	15.226	0.000	
var. *nov.*	9.625	6.421	10.118	0.000

Wilks' lambda = 0.3663 df = 3 3 91; approx. F= 8.9645, df = 12 233; prob = 0.0000

In the Classificatory Discriminant Analysis of the three named varieties and one putative unnamed variety of *S. altissima*, the percents of correct assignments of specimens for *var. altissima*, var. *gilvocanescens*, var. *pluricephala*, and putative "var. nov." were 48%, 59%, 68%, and 57%, respectively. The Classification matrix and Jackknife classification matrix are presented in Table 8. Results for individual a priori taxa are presented in decreasing order of percent correct placement. (1) 19 (68%) of the var. *pluricephala* specimens were assigned a posteriori to var. *pluricephala*; 7 specimens with 82-97% probability, 6 with 67-76% probability, and 4 with 54-65% probability. Nine specimens were assigned to other varieties: 6 to var. *altissima* with 45-74% probability and 3 to var. *gilvocanescens* with 41-47% probability. (2) 17 of the var. *gilvocanescens* specimens were assigned a posteriori to var. *gilvocanescens*; 6 with 81-96% probability, 3 with 70-79% probability, and 4

with 50-63% probability. Twelve specimens of var. *gilvocanescens* were assigned to other varieties: 5 to putative "var. nov." with 38-84% probability, 4 to var. *altissima* with 35-56% probability, and 3 to var. *pluricephala* with 46-56% probability. (3) 4 of the 7 (57%) putative "var. nov." specimens were assigned a posteriori to "var. *nov.*" with 80-100% probability. Two were assigned to var. *pluricephala* with 36-37% probability, and 1 to var. *gilvocanescens* with 44% probability. 4) 15 (48%) of the var. *altissima* specimens were assigned a posteriori to var. *altissima*; 2 with 82-90% probability, 5 with 68-72% probability, and 6 with 50-67% probability. Sixteen var. *altissima* specimens were assigned to other varieties: 9 to var. *pluricephala* with 39-79% probability, and 7 to var. *gilvocanescens* with 45-72% probability.

Table 8. Results of the Classificatory Discriminant Analysis of the four variety-level groups in *S. altissima*.

Classification matrix (a priori groups in left column, a posteriori assignments in rows)

	altissima	***gilvocanescens***	***pluricephala***	**var. *nov.***	**% correct**
altissima	15	7	9	0	48
gilvocanescens	4	17	3	5	59
pluricephala	6	3	19	0	68
var. *nov.*	0	1	2	4	57
Totals	25	28	33	9	58

Jackknifed classification matrix

	altissima	***gilvocanescens***	***pluricephala***	**var. *nov.***	**% correct**
altissima	15	7	9	0	48
gilvocanescens	4	17	3	5	59
canadensis	7	3	17	1	61
var. *nov.*	0	1	2	4	57
Total	26	28	31	10	56

probability, three with 70-79% probability, and four with 50-63% probability. Twelve specimens of var. *gilvocanescens* were assigned to other varieties: five to putative "var. nov." with 38-84% probability, four to var. *altissima* with 35-56% probability, and three to var. *pluricephala* with 46-56% probability. 3) Four of the seven (57%) putative "var. nov." specimens were assigned a posteriori to "var. *nov.*" with 80-100% probability. Two were assigned to var. *pluricephala* with 36-37% probability, and one to var. *gilvocanescens* with 44% probability. 4) Fifteen (48%) of the var. *altissima* specimens were assigned a posteriori to var. *altissima*; two with 82-90% probability, five with 68-72% probability, and six with 50-67% probability. Sixteen var. *altissima* specimens were assigned to other varieties: nine to var. *pluricephala* with 39-79% probability, and seven to var. *gilvocanescens* with 45-72% probability.

The results of the four variety canonical analysis are shown in Figure 9. Symbols for var. *gilvocanescens* and "var. nov." are distributed to the left on the first axis and var. *altissima* and var. *pluricephala* are central or to the right in the figure. The ellipses for 95% confidence limits are not fully separated. Eigenvalues for the first three canonical axes were 0.785, 0.346, and 0.136.

Three varietal taxa analysis of *S. altissima*

Data on the 88 specimens of *S. altissima* were used to generate a pair-wise Pearson Correlation Matrix. No pairs of traits had correlations greater than |0.7|. CAPL and CAPW were excluded as these were used to define a priori groups. Stepwise discriminant analysis selected the

following six traits in decreasing order of F-to-remove value as useful in separating the a priori groups in the analysis: INVOLHT (31.31), DISCNUM (10.24), DLOBL (7.20), RAYNUM (6.66), RSTRAPL (6.04), and RSTRAPW (5.12). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all three groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 9. F-values to separate indicate the largest separation was between *var. gilvocanescens* and var. *pluricephala*. The smallest separation was between var. *altissima* var. *pluricephala*.

Table 9. F-matrix for the discriminant analysis of three varietal groups in *S. altissima*.

	altissima	***gilvocanescens***	***pluricephala***
altissima	0.000		
gilvocanescens	13.588	0.000	
pluricephala	3.570	15.036	0.000

Wilks' lambda = 0.2954; df = 7 2 85; Approx. F= 9.4789; df = 14 158; prob = 0.0000

Table 10. Results of the Classificatory Discriminant Analysis of three variety-level groups in *S. altissima*.

Classification matrix (a priori groups in left column, a posteriori assignments in rows)

	altissima	***gilvocanescens***	***pluricephala***	**% correct**
altissima	19	5	7	61
gilvocanescens	0	28	1	97
pluricephala	6	0	22	79
Totals	24	33	30	78

Jackknifed Classification matrix

	altissima	***gilvocanescens***	***pluricephala***	**% correct**
altissima	18	5	8	58
gilvocanescens	1	27	1	93
pluricephala	8	0	20	71
Total	27	32	15	74

In the Classificatory Discriminant Analysis, the percent of correct assignments of specimens for var. *gilvocanescens*, var. *pluricephala*, and var. *altissima* were 97%, 79% and 61%, respectively The Classification matrix and Jackknife classification matrix are presented in Table 10. Results for individual a priori taxa are presented in decreasing order of percent correct placement. (1) Twenty-eight specimens of var. *gilvocanescens* were assigned a posteriori to var. *gilvocanescens*; 15 specimens with 90-100% probability, 5 with 70-89% probability, 8 with 50-69% probability. One specimen was assigned to var. *pluricephala* with 64% probability; this was tetraploid from Montana. (2) Twenty-two specimens of var. *pluricephala* were assigned a posteriori to var. *pluricephala*: 5 specimens with 92-97% probability, 2 with 80-86% probability, 6 with 70-79% probability, 3 with 64-69% probability, and 6 with 50-59% probability. Six specimens were assigned to var. *altissima* with 49-93% probability. These came from North Carolina, Alabama, Louisiana, Florida, and Texas. Two of them were tetraploid and 1 was hexaploid. One of the Texas specimens — *Johnston & Cheatham 12805* (TEX) — was originally identified by M.C. Johnston as var. *pluricephala*; the ploidy level is unknown; the inflorescence array is 13.5 cm tall by 11.5 cm wide and has leaf traits like other specimens of var. *pluricephala*; it was placed a posteriori into var. *altissima* with 57%

probability, into var. *pluricephala* with 34% probability, and into var. *gilvocanescens* with 10% probability. (3) Nineteen specimens of var. *altissima* were assigned a posteriori to var. *altissima*: 3 specimens with 90-94% probability, 6 with 70-86% probability, 5 with 61-66% probability, 4 with 50-58% probability, and 1 with 49% probability. Five specimens were assigned a posteriori to var. *gilvocanescens* with 66-85% probability. Six specimens were assigned to var. *pluricephala* with 51-78% probability.

The results of the three variety canonical analysis are shown in Figure 10. Symbols for var. *gilvocanescens* are distributed to the left on the first axis and var. *altissima* and var. *pluricephala* are central or to the right in the figure. The ellipses for 95% confidence limits are well separated. Eigenvalues for first two canonical axes were 1.499 and 0.277, respectively.

Var. *gilvocanescens, var. canadensis, var. hargeri* analysis

Data on the 81 specimens of *S. altissima* var. *gilvocanescens*, *S. canadensis* var. *canadensis*, and *S. canadensis* var. *hargeri* were used to generate a pair-wise Pearson Correlation Matrix. The following pairs of traits had correlations greater than |0.7|: INVOLHT-DCORL, INVOLHT-DPAPL, RSTRAPL-DCORL, RPAPL-DCORL, RPAPL-DPAPL, and DCORL-DPAPL. DCORL and DPAPL were not included in the discriminant analyses. MLFSERNUM and ULFSERNUM were not included because these were used in part to define a priori groups. Stepwise discriminant analysis selected the following six traits in decreasing order of F-to-remove value as useful in separating the a priori groups in the analysis: ULFW (23.33), RPAPL (13.82), MLFLN (10.20), OPHYLL (6.53), INVOLHT (6.16), and ULFLN (5.58). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all three groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 11. The largest F-value to separate was between var. *gilvocanescens* and var. *canadensis*. The smallest F-value to separate was between var. *canadensis* and var. *hargeri* with the F-value to separate between var. *gilvocanescens* and var. *hargeri* on slightly larger.

Table 11. F-matrix for the discriminant analysis of three varietal groups groups *S. altissima* var. *gilvocanescens, S. canadensis* var. *canadensis* and *S. canadensis* var. *hargeri*.

	gilvocanescens	***canadensis***	***hargeri***
gilvocanescens	0.000		
canadensis	26.264	0.000	
hargeri	14.754	11.164	0.000

Wilks' lambda = 0.1791; df = 6 2 78; Approx. F= 16.5822; df = 12 146; prob = 0.0000

In the Classificatory Discriminant Analysis, the percent of correct assignments of specimens for var. *gilvocanescens*, var. *canadensis*, and var. *hargeri* were 89%, 91%, and 81%, respectively. The Classification matrix and Jackknife classification matrix are presented in Table 12. Results for individual a priori taxa are presented in decreasing order of percent correct placement. (1) 29 specimens of var. *canadensis* were assigned a posteriori to var. *canadensis*: 17 specimens with 90-100% probability, 5 with 80-89% probability, 3 with 61-99%, 3 with 53-59% probability, and 1 with 44% probability. Three specimens were assigned a posteriori to var. *hargeri* with 65-78% probability. (2) 25 specimens of var. *gilvocanescens* were assigned a posteriori to var. *gilvocanescens*: 19 specimens with 90-100% probability, 4 with 70-89% probability, 1 with 54% probability. Three specimens were assigned a posteriori to other varieties. One tetraploid specimen from Minnesota was assigned to var. *altissima* with 75% probability. Two specimens were assigned a posteriori to var. *hargeri*; a diploid from Wisconsin had 52% probability of being var. *hargeri* and

42% probability of being var. *gilvocanescens*; a hexaploid from southeastern Colorado had 68% probability of being var. *hargeri*. (3) 17 specimens of var. *hargeri* were assigned a posteriori to var. *hargeri*: 9 specimens with 90-100% probability, 6 with 70-89% probability, and 2 with 64-66% probability. Three specimens were assigned to var. *canadensis* with 71%, 78%, and 86% probabilities, respectively. One specimen was assigned to var *gilvocanescens* with 69% probability; this was a diploid from Ohio with broader lanceolate leaves that were green rather than gray-green.

Table 12. Results of the Classificatory Discriminant Analysis of three variety-level groups *S. altissima* var. *gilvocanescens, S. canadensis* var. *canadensis* and *S. canadensis* var. *hargeri*.

Classification matrix (a priori groups in left column, a posteriori assignments in rows)

	gilvocanescens	***canadensis***	***hargeri***	**% correct**
gilvocanescens	25	1	2	**89**
canadensis	0	29	3	**91**
hargeri	1	3	17	**81**
Totals	26	33	22	**88**

Jackknifed Classification matrix

	gilvocanescens	***canadensis***	***hargeri***	**% correct**
gilvocanescens	25	1	2	**89**
canadensis	1	26	5	**81**
hargeri	1	3	17	**81**
Total	27	30	24	**84**

The results of the three variety canonical analysis are shown in Figure 11. Symbols for var. *gilvocanescens* are distributed to the left and center on the first axis and var. *canadensis* and var. *hargeri* are to the right and to the right and center-right, respectively, in the figure. On the second axis, symbols for var. *canadensis* are generally on the lower half of the graph, while those of var. *hargeri* are generally more on the upper half of the diagram with some overlap in distributions. The ellipses for 95% confidence limits are well separated. Eigenvalues for first two canonical axes were 2.174 and 0.759, respectively.

A plot of the discriminating traits ULFW versus INVOLHT for the three varieties is presented in Fig. 12. The 4 specimens of var. *canadensis* with the larger involucres are from Ontario and New Brunswick. The 3 specimens of var. *hargeri* with larger involucres are from Kentucky (85% probability of being var. *hargeri*), Wisconsin (64% probability of being var. *hargeri*) and Switzerland. The 3 specimens of var. *gilvocanescens* with smaller involucres are from Illinois (52% probability of being var. *gilvocanescens* and 20% of being var. *hargeri*) and Iowa (52% and 70% probability of being var. *gilvocanescens* and 19% and 29% of being var. *hargeri*, respectively); 2 were diploid and 1 is of unknown ploidy level.

DISCUSSION

Based on the results of all the analyses, the following taxa should be recognized: *Solidago altiplanities*, *S. altissima* var. *altissima*, *S. altissima* var. *gilvocanescens*, *S. altissima* var. *pluricephala*, *S. canadensis* var. *canadensis*, *S. canadensis* var. *hargeri,* and *S. juliae*. Support was not found for recognizing a new variety in *S. altissima* occurring in Canada along the northern margins of distribution of the species in the prairie / boreal forest ecotone. Additional field and herbarium work might alter this conclusion.

Four species level analysis

Based on the percents of correct assignments and the frequencies of high probabilities of those assignments, *Solidago altiplanities*, *S. altissima*, *S. canadensis*, and *S. juliae* are well supported as taxa. The largest F-to separate values in the Results occur in this analysis indicating the greatest amount of separation between species pairs *S. canadensis/S. juliae*, *S. altissima/S. juliae*, and *S. altiplanities/S. juliae* in the plots of multiple characters in N-dimension hyperspace on which the statistics are determined. In the classificatory discriminant analysis 0-11% decreases occurred in correct a posteriori classification values between the linear and jackknifed analyses. The 11% decrease involves just one specimen of *S. altiplanities*. This is not surprising because visually *S. juliae* is the most distinct species included in the analysis. Surprisingly, it is the most recent of the species to be described (Nesom 1989). Inclusion of *S. juliae* into *S. altissima* or *S. canadensis*, as had been done in floras prior to 1989, expands the ranges of some character traits in either of the latter to species to the point where recognizing the less distinct *S. altiplanities* would have been less defensible. Recognition of the two narrower leaved species *S. juliae* and *S. altiplanities* reduced the size of the problem in dealing with *S. altissima* and assigning specimens to species in the subsect. *Triplinerviae*. Additional analyses discussed below indicate that the real problem in the *S. altissima* complex is not with the relatively narrowly distributed *S. juliae* and *S. altiplanities* but instead with *S. altissima* and its infraspecific races and *S. canadensis* and its infraspecific races.

Six variety/species level taxa analysis

In the analyses involving more than one species and multiple varieties, the nomenclaturally established varieties within a species tended to be less differentiated from each other than from the other species. The largest F-to separate values are between *Solidago altiplanities* and all five varieties included in the analysis. The lowest F-to separate values were between the varieties of *S. altissima*. Within *S. canadensis*, recognition of var. *canadensis* and var. *hargeri* was supported, which was the conclusion reached in Semple et al. (2013) using the same *S. canadensis* data, but in comparison with other species than those included here. The percentages of correct a posteriori placements in the classificatory discriminant analysis were lowest for the three varieties of *S. altissima* and *S. canadensis* var. *hargeri*. The distinctness of these four taxa was explored in the two species/three varietal level analyses discussed below.

Three and four varietal taxa analyses of *S. altissima*

Two analyses were performed on just specimens of *Solidago altissima* to assess the significance of differences between the three named races and a fourth putative race within the species. The difference in level of support for four versus three races was considerable. The F-to separate values between var. *gilvocanescens* and var. *pluricephala* were about the same in the two sets of analyses and were the largest, but still low compared to F-to separate values in the four species analysis. The F-to separate value between var. *altissima* and var. *gilvocanescens* increased when the putative fourth variety was dropped as an a priori group. However, the F-to separate value between var. *altissima* and var. *pluricephala* decreased when the putative fourth variety was dropped as an a priori group, meaning the two varieties were less well supported in the three variety analysis than the four variety analysis in terms of amount of group centroid separation in the N-dimension hyperspace plot of discriminating characters. However, the percentages of correct place increased for all three named varieties when the putative fourth variety was not included as an a priori group; the average value of placement to variety went from 58% to 78%. Inclusion of a putative fourth variety was disruptive. Sample size for this putative variety was small, but the number of characters selected by the stepwise discriminant analysis was lower than the number selected when only three varieties were included as a priori groups. The conclusion that a fourth variety should not be recognized at this time seems obvious based on the data available.

Support for recognizing var. *pluricephala* as a distinctive southeastern USA race of *Solidago altissima* is moderate and much less well supported than treating the western var. *gilvocanescens* as a distinct race from the eastern var. *altissima*. The original trait used to distinguish var. *pluricephala* was an elongated inflorescence array like those found in *S. juliae*, *S. altiplanities*, and *S. leavenworthii*, which was not included in the set of analyses reported here. However, this trait was not consistent and assignment to the a priori groups var. *altissima* and var. *pluricephala* was based primarily on geography with the latter being found on the coastal plain and outer Piedmont in the Carolinas, Georgia, and Alabama. Geography is a somewhat arbitrary trait and this may account for the higher number of "mis-assignments" indicated by the results of the classificatory discriminant analyses. Even a specimen *M.C. Johnston & Cheatham 12805* (TEX) from extreme southern Texas that was identified as var. *pluricephala* by the author of the taxon was placed weakly into var. *altissima*. The specimen vegetatively looks generally more like var. *pluricephala* than var. *altissima*, even if the technical traits are atypical for var. *pluricephala*. This was also true for some of the other var. *pluricephala* specimens assigned a posteriori to var. *altissima*. The fact that 71% of the var. *pluricephala* specimens were assign a posteriori to var. *pluricephala* is noteworthy. It is true that var. *pluricephala* is not always easily distinguished from var. *altissima*, especially in the area where the Coastal Plain flora and the inland-upland-more northern floras come together. It is the first author's opinion that it is useful to recognize var. *pluricephala* and doing so is consist with how other previously ignored species and varieties are now being recognized (Semple, 2014, continuously updated, Classification of Solidago, Astereae Lab web site).

Whether or not var. *gilvocanscens* should be treated as a separate species because it is more distinct is a reasonable question to ask. The statistics indicate that var. *gilvocanescens* is not as strongly separated from var. *altissima* (and var. *pluricephala*) as are *Solidago altiplanities* and *S. juliae* from *S. altissima*. The size of the F-to separate values, the percentages of correct placements, and the probabililties of those placements are all lower than what the Astereae Lab has found to be usual for species level recognition in asters and goldenrods. Also, var. *gilvocanescens* includes the only diploids known in *S. altissima* and is thus likely the ancestor of both var. *altissima* and var. *pluricephala* which include some tetraploids and mostly hexaploids. Ploidy level alone is not a basis for treating var. *gilvocanescens* as a separate species because it also includes many tetraploids and some hexaploids. Halverson et al. (2008) reported that AFLP marker data suggested that polyploid cytotypes in *S. altissima* likely have multiple origins from different diploid lineages. This means that var. *altissima* and var. *pluricephala* possibly are polyphyletic in the strictest sense. Schlaepfer et al. (2008) concluded that tetraploids in *S. gigantea* were much more likely to have evolved multiple times than from a single event, and they suggested that as many as seven independent origins for tetraploids had occurred in eastern North America. Peirson et al. (2012) reported on the cytogeography of subsect. *Humiles* (Rydb.) Semple (the *S. simplex* complex) and discussed problems with species concepts as applied to the genus. Peirson et al. (2013) concluded the same as Halverson et al. (2008) but regarding the multiple origins for polyploids in subsect. *Humiles* and that "recurrent formation of polyploid lineages is the norm in many plants." Semple and Peirson (2013) treated nearly all of the infraspecific taxa in S. *simplex* listed in Semple and Cook (2006) as separate species. Separate races were not recognized in *S. gigantea*. The races in *S. altissima* appear to be more distinct (more geographically discrete, less intergrading) than those in *S. gigantea*. The patterns of distributions of the different ploidy levels differ in the two species (Semple et al. 1984; Semple & Cook 2006; Peirson et al. 2012). Treating var. *gilvocanescens* as subsp. *gilvocanescens* does not clarify the problem because of differences of opinion on application of the rank subspecies. For consistency, the three races of *S. altissima* have been designated varieties in this paper, without implication that the ranks subspecies and variety are essentially the same or that the former should just be used as a grouping category only.

Var. *canadensis*, var. *hargeri*, var. *gilvocanescens* analysis

The results also provide statistical support for the generally held opinion that the *Solidago altissima*/*S. canadensis* identification problem is real. While *S. altissima* and *S. canadensis* should be treated as separate species, the existence of diploids in *S. altissima* var. *gilvocanescens* and only diploids in *S. canadensis* var. *hargeri* increases the difficulty of placing individual specimens into one or the other variety. Smaller headed, proximally hairy-stemmed plants with lower numbers of serrations on upper stem leaves are the main challenge. The plot of upper leaf width versus involucre height in Figure 12 indicates some of the difficulty in separating the three varieties. The var. *canadensis* specimens with larger involucres came from New Brunswick and southeastern Ontario, which are outside the range of var. *gilvocanescens*. The two specimens of var. *hargeri* with larger involucres came from Kentucky and Wisconsin from the portion of the range that overlaps with that of var. *gilvocanescens*; these were placed in var. *hargeri*. The third came from Switzerland in Europe and was placed in var. *canadensis* in this analysis, but it was placed in var. *hargeri* in the analysis in Semple et al. (2013). The three specimens of var. *gilvocanescens* with smaller involucres came from Illinois and Iowa — these were placed in the analysis into var. *gilvocanescens*, and two were known to be diploid. While *S. canadensis* var. *hargeri* generally has greener upper leaves with larger teeth than specimens of *S. altissima* var. *gilvocanescens*, the leaves of both tend to be wider than those of var. *canadensis*. Leaf color can be changed by drying conditions and age, making that trait less reliable. For those who really need an identification that is highly accurate and with high probability of being correct, an alternative method, i.e., molecular, is needed to further explore the relationships of these three varieties and to find more reliable ways of identifying problematic individual specimens. Scoring multiple traits on a specimen and running a discriminant analysis to determine its identification is clearly not a convenient method either.

ACKNOWLEDGEMENTS

This work was supported by a Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grants to JCS. NSERC Undergraduate Student Research Awards to HF is acknowledged. Daniel Schlaepfer is thanked for collections of *S. canadensis* from Europe used in this study. Derick Poindexter is thanks for specimens of *S. canadensis* from North Carolina used in this study. Joan Venn is thanked for her help with processing loans in and out of WAT and for assisting the late J.K. Morton in collecting numerous specimens used in this study. The curators of herbaria that loaned specimens are gratefully acknowledged. Jennifer A. Hood, Imram Khamis, Haris Faheemuddin, and Y. Alex Chong are thanked for technical assistance at different stages in the project.

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Table 2. Group means of the means of all taxa of the *S. altissima* complex included in the analyses; mean, standard deviation, minimum and maximum given for each trait.

species	***altiplanites***	***altissima***			***canadensis***		***juliae***
variety		***altissima***	***gilvo-canescens***	***pluri-cephala***	***canaden-sis***	***hargeri***	
STMHT	**60.5**	**89.9**	**80.1**	**93.0**	**90.6**	**110.5**	**95.2**
(cm)	16.42	25.99	25.34	24.14	29.07	45.07	38.18
	35.5	54.5	45.8	41.0	47.5	58.0	60
	84.7	163.0	163.5	155.0	155.5	182.5	180
MLFLN	**43.4**	**74.1**	**62.6**	**68.8**	**73.7**	**89.6**	**50.2**
(mm)	6.83	14.75	12.17	14.32	15.88	25.7	11.37
	28.3	43.6	39.8	51.5	49.6	52.0	31.8
	50.2	99.0	85.0	111.5	105.000	162.5	65.0
MLFW	**5.1**	**11.0**	**11.2**	**11.4**	**8.4**	**13.3**	**7.2**
(mm)	1.339	2.67	2.79	1.98	2.106	3.88	2.19
	3.7	6.8	5.6	7.8	3.4	4.25	5.1
	8.0	17.3	16.0	15.3	12.2	22.5	13.2
MLFSER-NUM	**0.9**	**6.3**	**5.9**	**6.3**	**7.0**	**8.7**	**3.1**
	1.25	2.64	2.63	1.54	2.28	4.146	4.49
	0.0	0.33	2.0	3.8	2.8	0.4	0.0
	3.6	11.0	14.3	10.8	11.6	16.0	13.8
ULFLN	**29.9**	**45.2**	**41.7**	**45.5**	**47.8**	**49.8**	**46.30**
(mm)	6.16	12.16	8.46	12.97	10.78	18.47	8.82
	23.5	26.0	25.3	26.8	27.4	14.4	30.00
	40.0	80.0	62.7	73.5	76.25	84.5	61.25
ULFW	**3.5**	**7.2**	**8.4**	**8.1**	**5.7**	**7.9**	**14.1**
(mm)	0.72	1.87	1.88	3.10	1.38	2.085	3.49
	2.4	4.0	5.0	5.0	3.0	3.0	10.1
	4.3	12.3	12.0	20.3	9.0	11.8	21.8
ULFSER-NUM	**0.04**	**2.7**	**3.8**	**3.8**	**3.4**	**4.2**	**18.0**
	0.133	1.82	2.40	1.49	2.62	3.22	7.34
	0.0	0.0	0.0	1.0	0.0	0.0	12.2
	0.4	6.2	8.8	9.4	8.8	10.8	34.25

Table 2. Continued.

species	*altiplanites*	*altissima*		*canadensis*			*juliae*
variety		*altissima*	*gilvo-canescens*	*pluri-cephala*	*canaden-sis*	*hargeri*	
CAPL	**14.9**	**18.2**	**17.2**	**19.2**	**12.7**	**19.2**	**21.7**
(cm)	7.15	7.76	7.46	6.74	4.61	7.36	8.44
	8.8	7.4	5.4	7.5	4.0	8.8	11.0
	30.0	37.0	35.7	38.0	26.0	34.5	37.0
CAPW cm	**4.7**	**12.6**	**11.8**	**11.1**	**9.2**	**16.0**	**8.3**
	4.45	5.53	5.035	4.030	3.54	7.058	1.73
	2.2	5.0	3.8	3.5	4.0	4.0	5.5
	15.5	35.0	25.0	20.0	15.5	26.7	11.0
INVOLHT	**4.0**	**3.5**	**2.9**	**3.5**	**2.1**	**2.4**	**3.4**
(mm)	0.197	0.36	0.35	0.34	0.38	0.54	0.25
	3.8	2.8	2.0	2.9	1.3	1.7	2.9
	4.4	4.4	3.5	4.4	3.2	4.2	3.7
OPHYLL	**1.7**	**1.2**	**1.1**	**1.1**	**1.1**	**1.06**	**1.3**
(mm)	0.94	0.16	0.20	0.132	0.27	0.23	0.13
	1.1	0.89	0.8	0.8	0.69	0.7	1.0
	4.1	1.5	1.8	1.4	2.09	1.8	1.5
IPHYLL	**3.5**	**2.6**	**2.1**	**2.6**	**1.8**	**1.9**	**2.8**
(mm)	0.298	0.69	0.405	0.64	0.4	0.34	0.22
	3.06	1.4	1.6	1.7	0.9	1.1	2.5
	3.9	4.0	2.9	3.8	2.54	2.6	3.1
RAYNUM	**7.1**	**9.7**	**8.6**	**7.6**	**9.3**	**8.0**	**10.4**
	1.73	2.42	2.14	3.02	1.9	1.83	1.77
	5.0	3.8	3.5	2.0	6.	5	7.3
	9.4	13.8	11.8	11.8	13	12	13.2
RSTRAPL	**1.6**	**1.3**	**1.2**	**1.4**	**0.87**	**0.9**	**1.3**
(mm)	0.44	0.19	0.2	0.30	0.288	0.204	0.25
	0.8	0.9	.30	0.97	0.32	0.56	0.9
	2.2	1.6	1.625	1.8	1.45	1.3	1.6
RSTRAPW	**0.5**	**0.27**	**0.31**	**0.29**	**0.19**	**0.25**	**0.3**
(mm)	0.12	0.100	0.104	0.109	0.058	0.066	0.083
	0.3	0.14	0.15	0.10	0.10	0.14	0.2
	0.7	0.48	0.50	0.60	0.30	0.38	0.5
RACHBL	**1.1**	**0.75**	**0.75**	**0.73**	**0.79**	**0.68**	**0.79**
(mm)	0.37	0.172	0.210	0.166	0.31	0.277	0.193
	0.6	0.43	0.43	0.40	0.30	0.3	0.54
	1.8	1.04	1.4	1.13	1.94	1.3	1.18

Table 2. Continued.

species	*altiplanites*	*altissima*			*canadensis*		*juliae*
variety		*altissima*	*gilvo-canescens*	*pluri-cephala*	*canaden-sis*	*hargeri*	
RPAPL	**3.3**	**2.8**	**2.4**	**2.9**	**1.6**	**1.62**	**2.2**
(mm)	0.34	0.36	0.37	0.34	0.37	0.33	0.45
	2.8	2.1	1.8	2.1	1.0	0.66	1.0
	3.9	3.4	3.1	3.6	2.3	2.04	2.8
DISCNUM	**9.6**	**4.3**	**4.7**	**4.2**	**4.6**	**3.9**	**5.8**
	2.13	0.87	1.33	1.26	1.2	1.18	1.013
	7.4	2.7	2.03	3.0	2	1.8	3.8
	13.2	5.8	8.3	9.2	7	6.2	7.7
DCORL	**3.7**	**3.7**	**3.1**	**3.9**	**2.3**	**2.5**	**3.2**
(mm)	0.457	0.46	0.40	0.55	0.598	0.35	0.23
	2.67	3.0	2.2	3.1	0.6	1.5	2.8
	4.2	5.1	3.9	4.9	3.3	3.0	3.5
DLOBL	**1.1**	**0.77**	**0.83**	**0.85**	**0.53**	**0.65**	**2.0**
(mm)	0.15	0.157	0.240	0.153	0.189	0.187	0.15
	0.8	0.48	0.54	0.50	0.23	0.42	1.8
	1.3	1.01	1.75	1.04	0.90	1.13	2.3
DACHBL	**0.97**	**0.73**	**0.72**	**0.75**	**0.74**	**0.67**	**1.1**
(mm)	0.278	0.136	0.193	0.157	0.22	0.267	0.27
	0.57	0.52	0.43	0.50	0.33	0.40	0.8
	1.52	1.02	1.34	1.22	1.17	1.48	1.7
DPAPL	**3.4**	**3.0**	**2.6**	**3.3**	**1.8**	**1.79**	**2.3**
(mm)	0.40	0.351	0.397	1.36	0.37	0.404	0.26
	2.8	2.5	1.7	2.3	1.2	0.78	2.2
	3.9	3.8	3.3	10.1	2.4	2.51	3.0

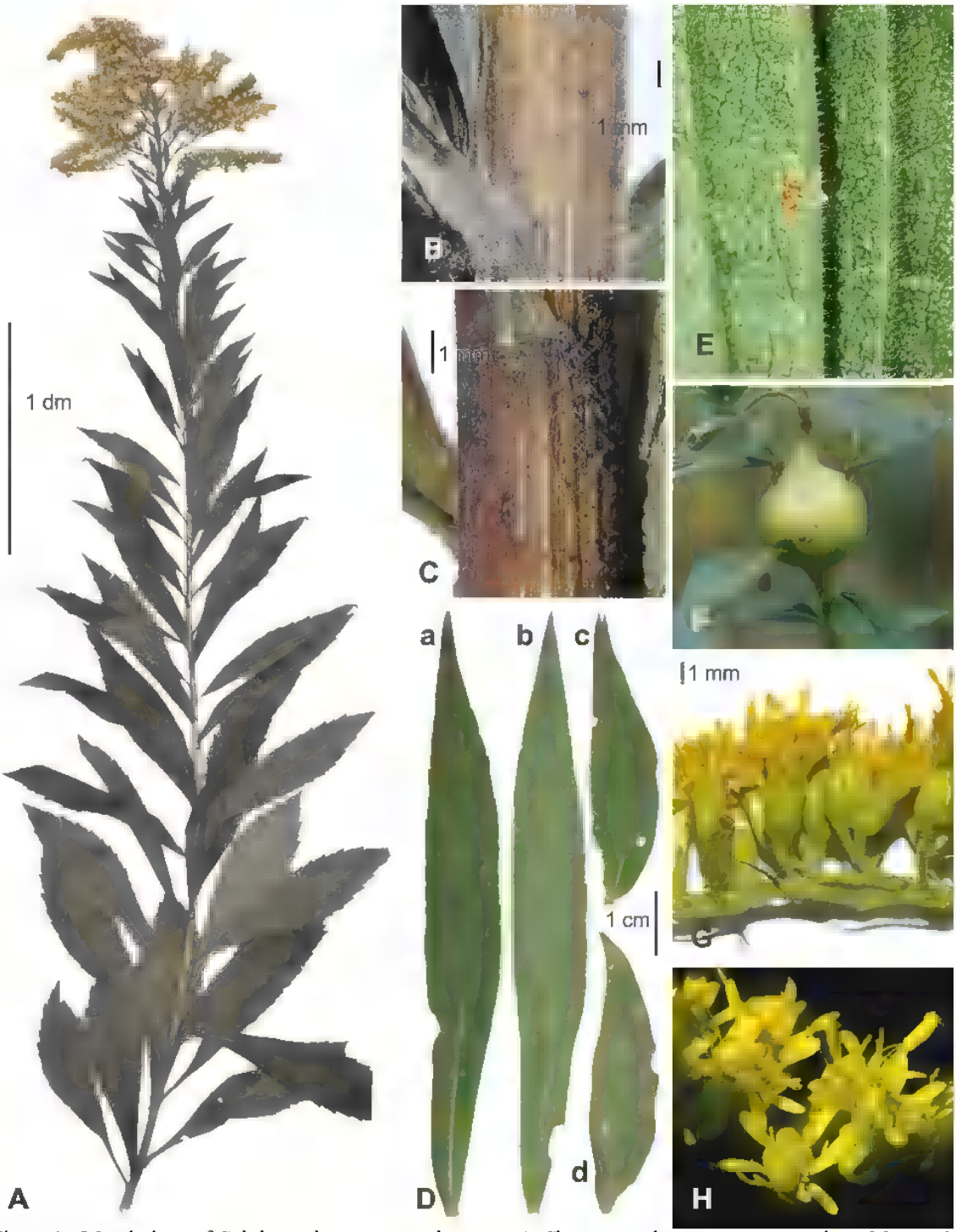

Figure 1. Morphology of *Solidago altissima* var. *altissima*. A. Shoot, greenhouse grown transplant, *Morton & Venn NA176142* (JKM), New Brunswick. B. Upper stem, *Semple & Brammall 2791* (WAT), Ontario. C. Lower mid stem, *Semple 6816* (WAT), New York. D. Mid (a, b) and upper stem leaves (c, d), adaxial surfaces (a, c), abaxial surface (b, d), Ontario. F. Stem ball gall, Ontario. G. Involucres, Ontario. H. Florets, Ontario.

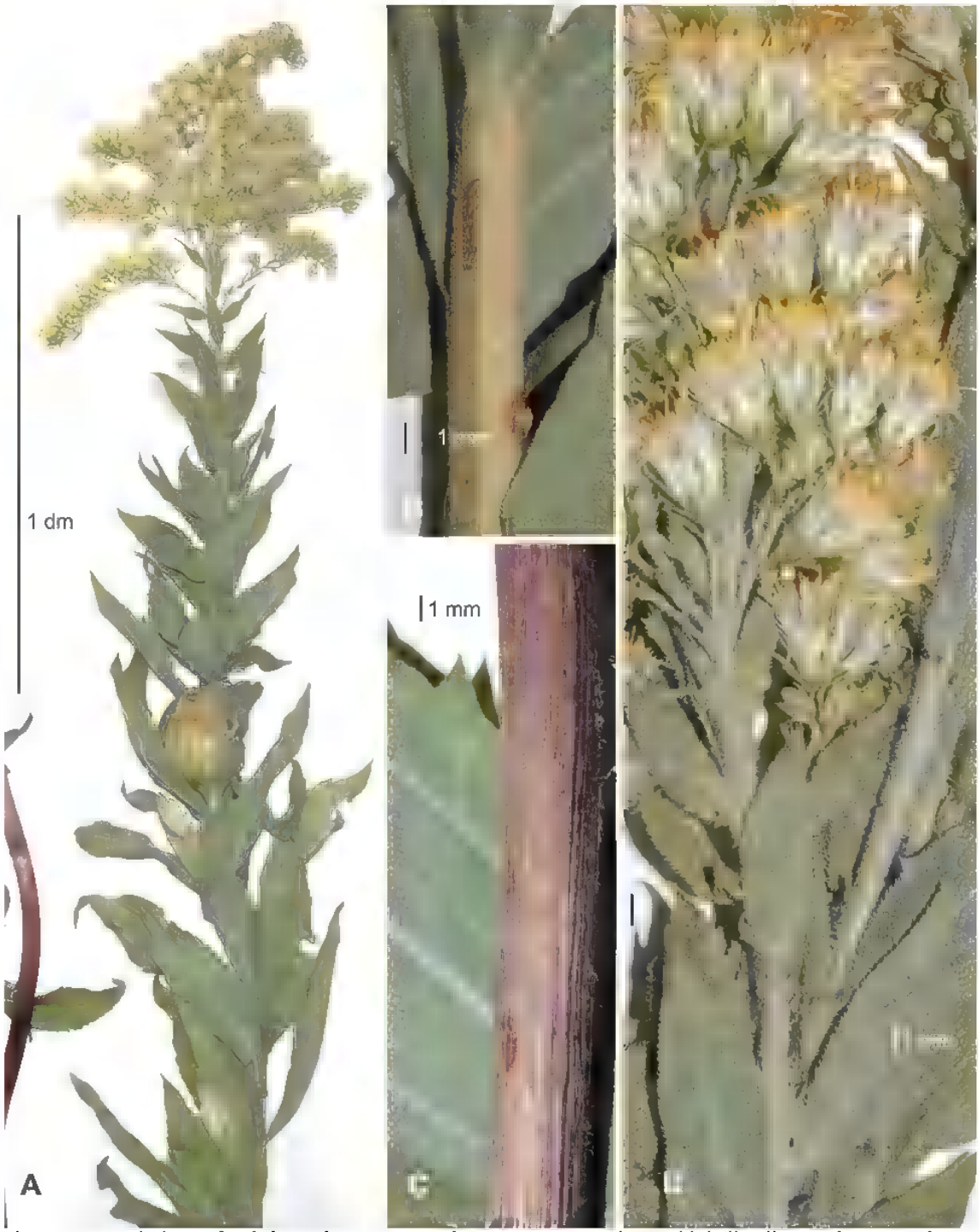

Figure 2. Morphology of *Solidago altissima* var. *gilvocanescens*. A. Shoot with ball gall, *Semple & Semple 6678* (WAT), North Dakota. B. Mid stem, *Semple & Brouillet 6978* (WAT), Montana. C. Lower stem, *Morton & Venn NA15651* (JKM). D. Heads, *Oldham 30688* (WAT).

Figure 3. Morphology of *Solidago altissima* var. *pluricephala*. A. Mid-size shoot, *Semple & Suripto 10076* (WAT). B. Stem, lower, *Morton & Venn NA16471* (JKM). C. Mid stem leaves, Paine Prairie, Florida. D. Inflorescence, Paine Prairie, Florida.

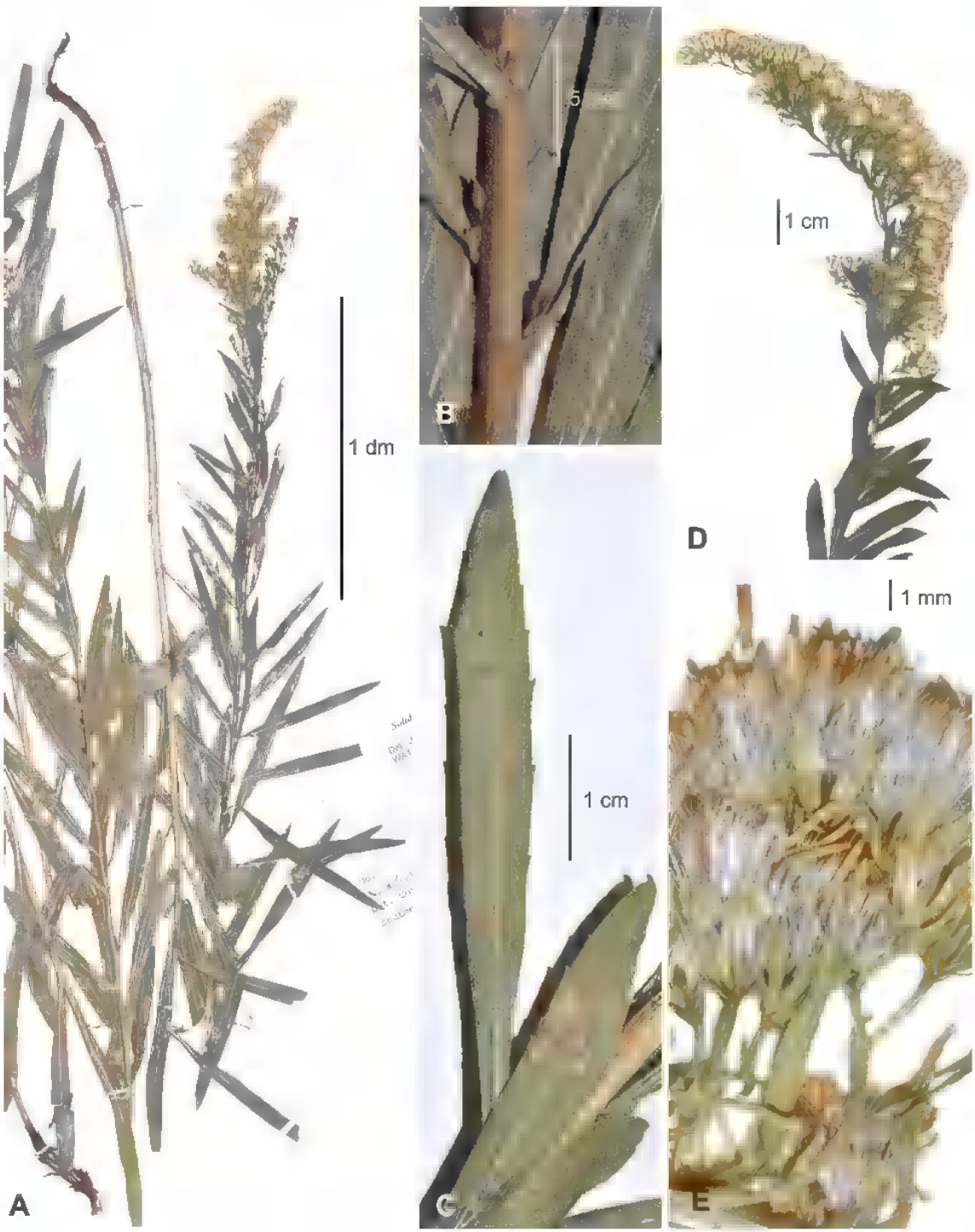

Figure 4. Morphology of *Solidago altiplanities*. A. Shoot, *Pace 150* (BRIT). B. Mid stem, *Correll 13031* (BRIT). C. Lower stem leaves, *Waller 1583* (BRIT). D. Inflorescence, *Correll 38035* (BRIT). E. Heads, *Nesom & O'Kennon LAMR 984* (BRIT).

Figure 5. Morphology of *Solidago juliae*. A. Mid-size shoot, *Nesom & Nesom 7211* (WAT). B. Stems. C. Mid stem leaves. D. Inflorescence. E. Heads. Isotype, *Nesom & Nesom 7212* (WAT).

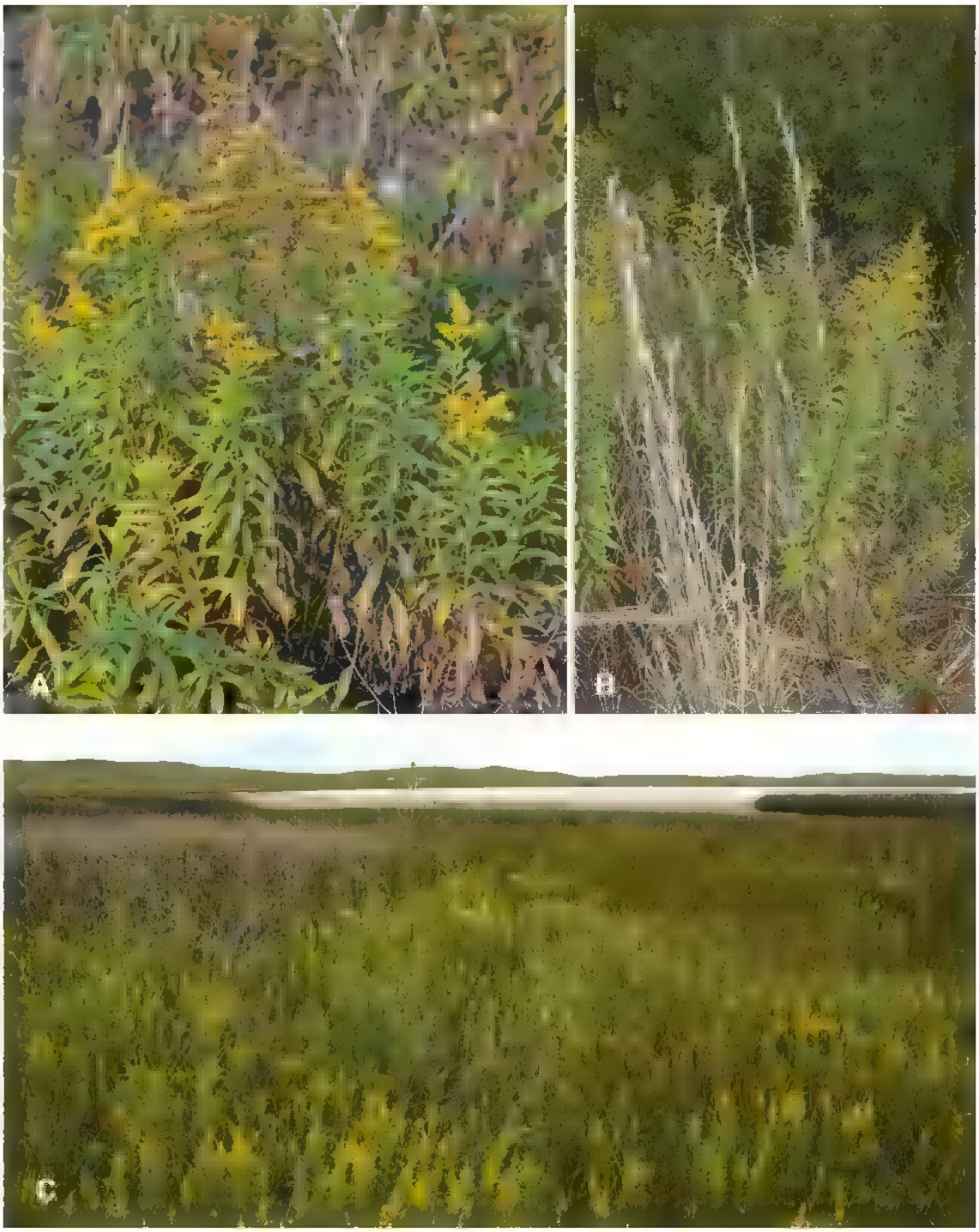

Figure 6. *Solidago altissima* habits and habitats. A. Var. *altissima*, Ontario. B. Var. *gilvocanescens*, sandhills, Nebraska. C. Var. *pluricephala*, prairie, Florida.

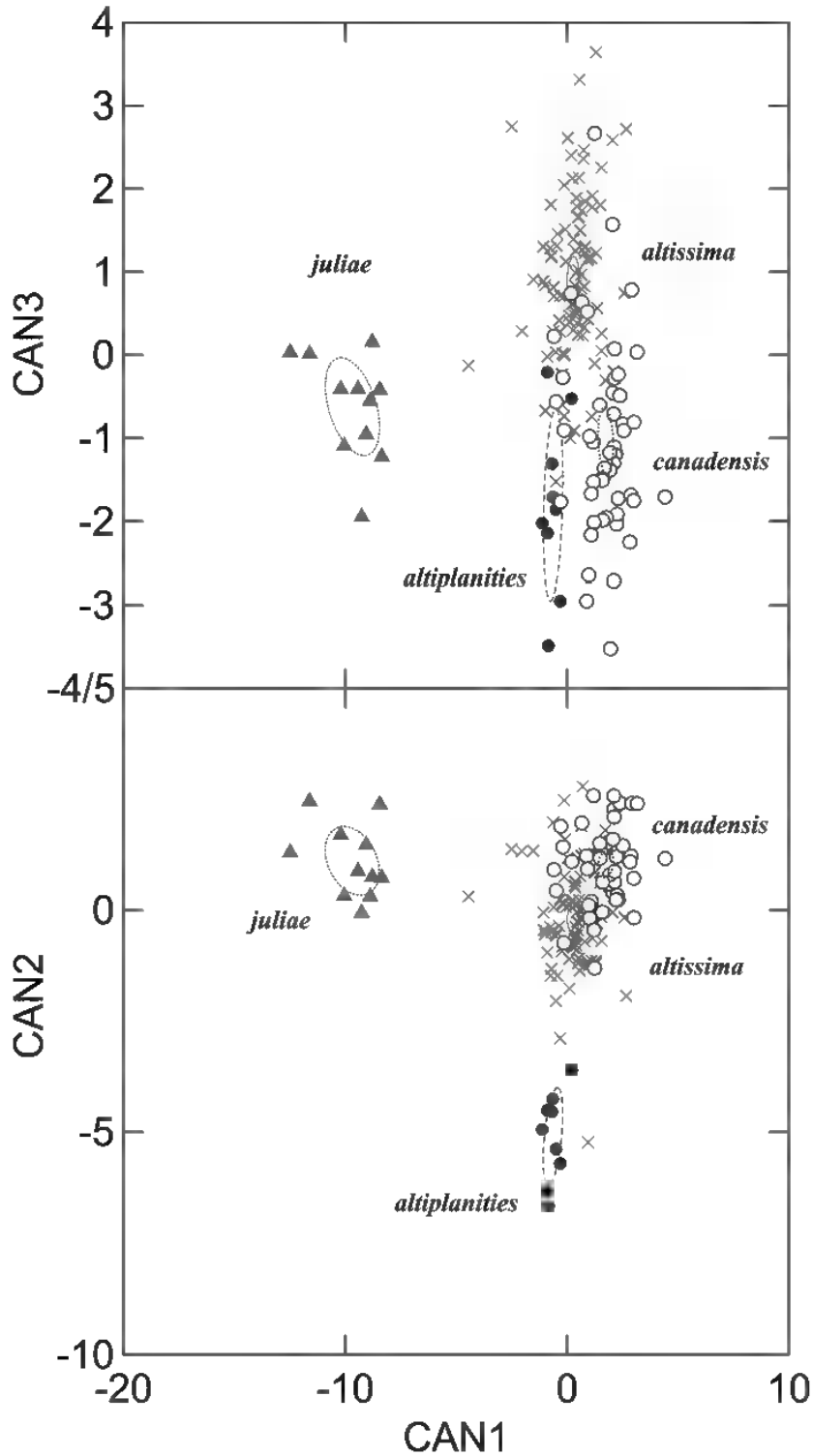

Figure 7. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores generated by the Canonical Analysis of specimens of the *Solidago S. altissima/S. canadensis* complex; solid dots = *S. altiplanities*, gray crosses = *S. altissima*, circles = *S. canadensis*, gray triangles = *S. juliae*; 95% confidence ellipses are shown for each taxon.

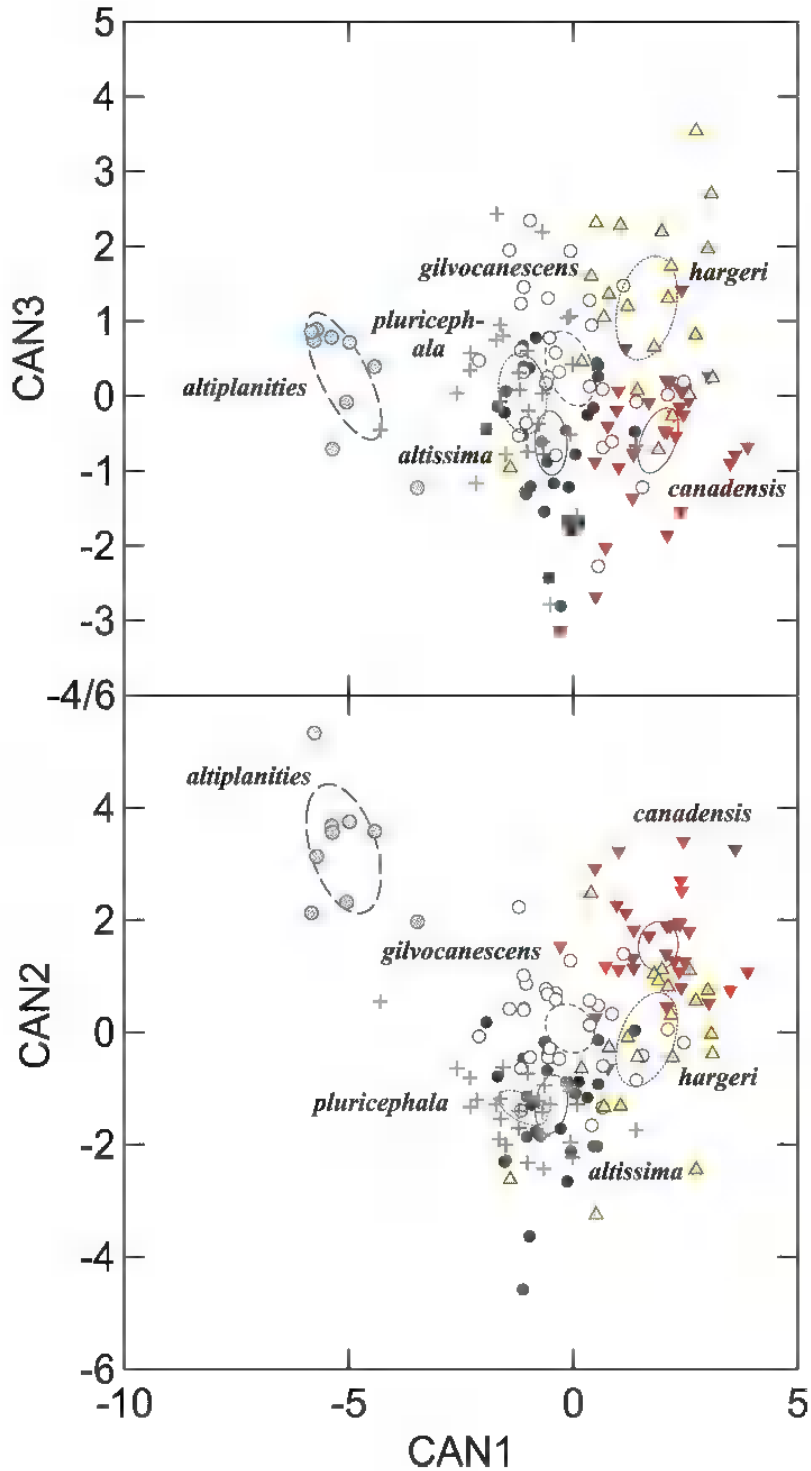

Figure 8. Two dimensional plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores generated by the Canonical Analysis of specimens of the *Solidago altiplanities* and the four varieties of *S. altissima* and *S. canadensis*; blue dots = *S. altiplanities*, black dots = *S. altissima* var. *altissima*, open circles = *S. altissima* var. *gilvocanescens*, gray pluses = *S. altissima* var. *pluricephala*, red triangles = *S. canadensis* var. *canadensis*, yellow triangles = *S.. canadensis* var. *hargeri*; 95% confidence ellipses are shown for each taxon.

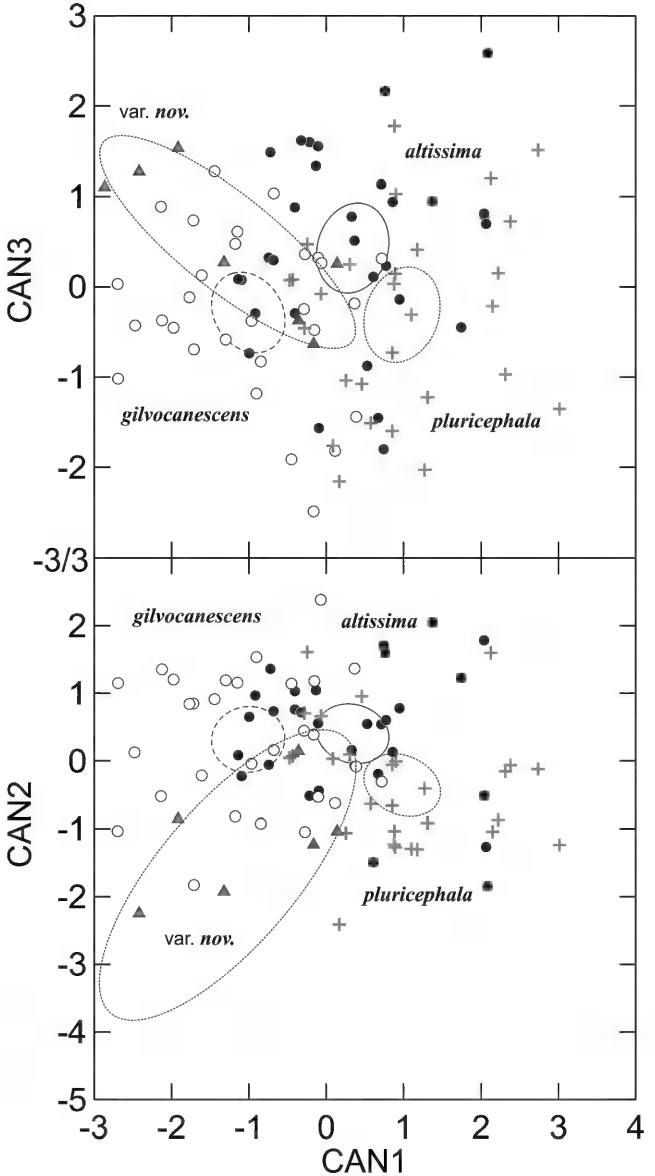

Figure 9. Two dimensional plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores generated by the Canonical Analysis of specimens of four possible varieties of *Solidago altissima*; black dots = var. *altissima*, var. open circles = var. *gilvocanescens*, gray pluses = var. *pluricephala*, gray triangles = var. *nov.*; 95% confidence ellipses are shown for each taxon.

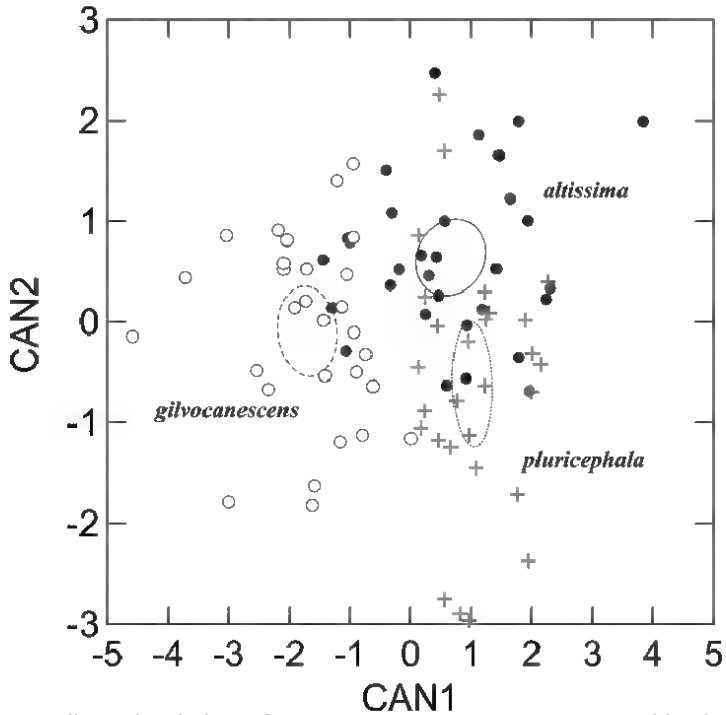

Figure 10. Two dimensional plots of CAN1 versus CAN2 scores generated by the Canonical Analysis of specimens of three varieties of *Solidago altissima*; black dots = var. *altissima*, var. open circles = var. *gilvocanescens*, gray pluses = var. *pluricephala*; 95% confidence ellipses are shown for each taxon.

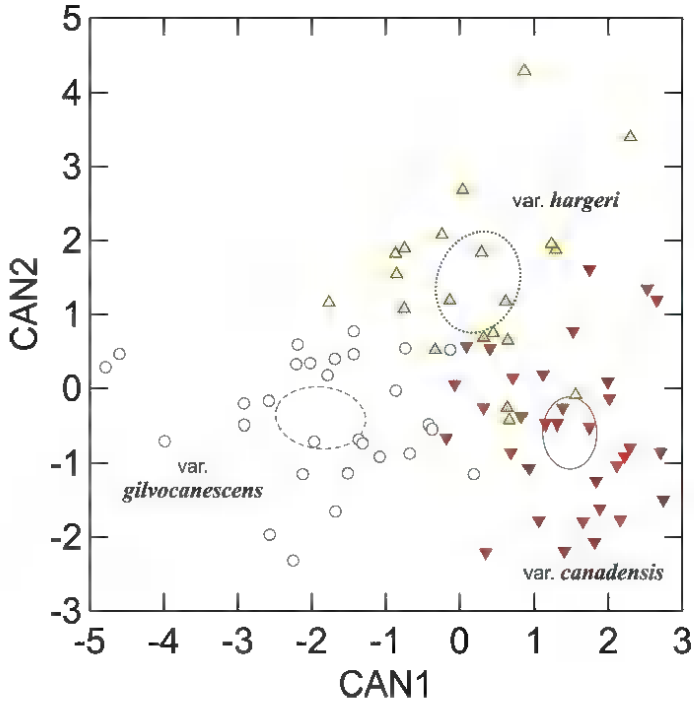

Figure 11. Two dimensional plots of CAN1 versus CAN2 scores generated by the Canonical Analysis of specimens of *Solidago altissima* var. *gilvocanescens, S. canadensis* var. *canadensis* and *S. canadensis* var. *hargeri*; open circles = var. *gilvocanescens*, red triangles = var. *canadensis*, yellow triangles = var. *hargeri*; 95% confidence ellipses are shown for each taxon.

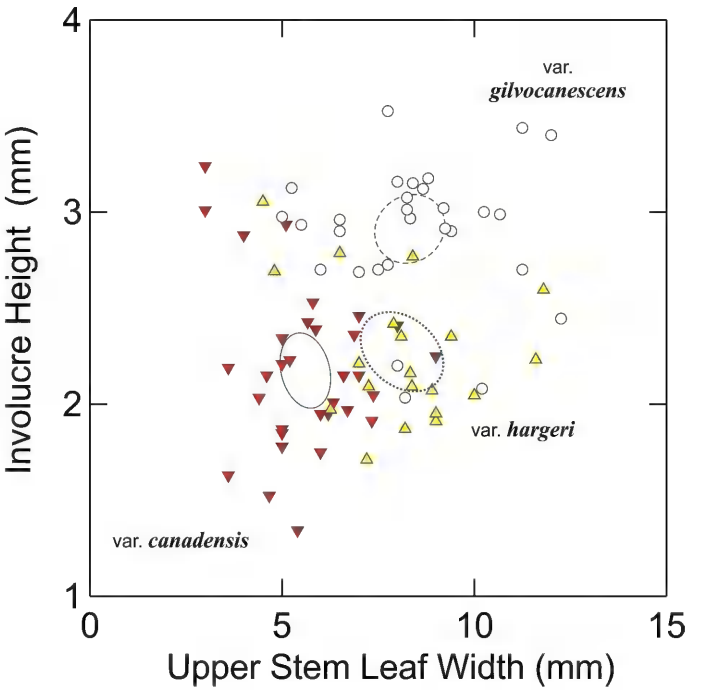

Figure 12. Two dimensional plot of upper leaf width versus involucre height for specimens of of *Solidago altissima* var. *gilvocanescens, S. canadensis* var. *canadensis* and *S. canadensis* var. *hargeri*; open circles = var. *gilvocanescens*, red triangles = var. *canadensis*, yellow triangles = var. *hargeri*; 95% confidence ellipses are shown for each taxon.

Naczi, R.F.C., D.B. Poindexter, C.T. Bryson, D.A. Werier, and D. Estes. 2015. New state records of *Carex* sect. *Acrocystis* (Cyperaceae) from the eastern USA. Phytoneuron 2015-11: 1–4. Published 12 February 2015. ISSN 2153 733X

NEW STATE RECORDS OF *CAREX* SECT. *ACROCYSTIS* (CYPERACEAE) FROM THE EASTERN USA

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ABSTRACT

Cited voucher specimens document *Carex albicans* var. *emmonsii* new to Mississippi, *C. floridana* new to New Jersey and Tennessee, *C. reznicekii* new to Florida, *C. tonsa* var. *rugosperma* new to Tennessee, and *C. tonsa* var. *tonsa* new to Kentucky and Tennessee.

Members of *Carex* sect. *Acrocystis* Dumort. (Cyperaceae) are serious identification challenges in the North American Flora. Several aspects of these plants make them difficult to identify, particularly the relatively few interspecific diagnostic characters and the often great intraspecific variability. In addition, members of sect. *Acrocystis* are diminutive, with *C. reznicekii* Werier, *C. tonsa* (Fernald) E.P. Bicknell, and *C. umbellata* Willd. among the smallest of all *Carex* species in temperate eastern North America. Also, most of the species of sect. *Acrocystis* mature and shed the diagnostic perigynia quickly. Yet another identification challenge is due to frequent hybridization between the species, though individuals of the species usually far outnumber hybrids at sites where hybrids do occur (pers. observations by Naczi, Poindexter, and Werier).

Complicating matters, taxonomy within *Carex* sect. *Acrocystis* is incompletely resolved. For example, authors only recently have described multiple new species from North America, *C. reznicekii* (Werier 2006), *C. austrodeflexa* P.D. McMillan, Sorrie, & van Eerden (Sorrie et al. 2011), and *C. xerophila* Janeway & Zika (Zika et al. 2014), and have proposed a new combination and status for *C. austrolucorum* (Rettig) D.B. Poind. & Naczi (Poindexter & Naczi 2014).

Largely because of their identification challenges, geographic distributions of members of *Carex* sect. *Acrocystis* are incompletely known. In order to increase knowledge of the distributions of species in the section, we report significant collections of five taxa, *C. albicans* var. *emmonsii* (Torr.) Rettig, *C. floridana* Schwein., *C. reznicekii*, *C. tonsa* var. *rugosperma* (Mack.) Crins, and *C. tonsa* var. *tonsa*. These collections are from five states in the eastern USA. Apparently, all cited specimens are new state records since records for these states are lacking from the most recent comprehensive treatment of sect. *Acrocystis* for North America (Crins & Rettig 2002), from the PLANTS database (USDA 2015), from the Atlas of Florida Vascular Plants (Wunderlin & Hansen 2015), from the Database of Tennessee Vascular Plants (University of Tennessee Herbarium 2015), and from the protologue of *C. reznicekii* (Werier 2006).

Taxonomy and nomenclature follow Crins and Rettig (2002).

Carex albicans var. emmonsii

Carex albicans var. *emmonsii* grows in wet-mesic and mesic, deciduous and deciduous-pine forests and their edges. Its known geographic range had been Nova Scotia west to Ontario, south to Florida, Tennessee, and Arkansas (Crins & Rettig 2002). The specimens cited below extend the range into central Mississippi.

Mississippi. Lauderdale Co.: John C. Stennis Naval Auxiliary Air Station, 24 Apr 2009, *Bryson 23080 & Copeland* (NY). Lowndes Co.: Columbus, Propst Park, N of route 182, W of Luxapallila Creek, 10 Apr 2010, *Bryson 23327 & Bryson* (NY). Madison Co.: Flora, 2 Apr 1955, *Cooley et al. 3364* (FLAS). Oktibbeha Co.: Sturgis, Diane Jackson Memorial Park, 3 Apr 2010, *Bryson 23302 & Bryson* (NY), *Bryson 23303 & Bryson* (NY). Winston Co.: ca. 7 air mi WNW of center of Louisville, Tombigbee National Forest, 20 Apr 2010, *Bryson 23146 et al.* (NY).

Carex floridana

Carex floridana grows in dry-mesic sands and very sandy soils in open woods and their edges. This species had been known from Virginia south and west in coastal states to Florida and Texas, and inland in Arkansas and Missouri (Crins & Rettig 2002; USDA 2015; Virginia Botanical Associates 2015). The specimens cited from New Jersey represent a northeastward range extension of about 170 km (105 mi) from southeastern Virginia to southernmost New Jersey. The Tennessee population represents a slight northward extension from an occurrence in northern Mississippi (USDA 2015).

New Jersey. Cape May Co.: Wildwood Beach, 8 May 1898, *Saunders s.n.* (PH); West Cold Spring, Higbee's Beach, 28 May 1911, *Brown s.n.* (PH); N of Bennett, 7 May 1932, *Witte s.n.* (PH). **Tennessee**. Fayette Co. 0.53 air mi SSW of La Grange, 300 feet W of Yager Rd., 19 Apr 2013, *Estes 2013-26C* (APSC, NCU); from population represented by *Estes 2013-26C*, grown in greenhouse and harvested for chromosome analysis, 31 Jan 2014, *Poindexter 14-19* (NCU).

Carex reznicekii

Carex reznicekii grows in mesic deciduous or deciduous-pine forests. Its previously known range extended from Rhode Island west to southern New York, southern Ohio, and southern Missouri, south to southern Georgia, Alabama, Mississippi, and northern Arkansas (Werier 2006; USDA 2015). The record cited below is a slight southward range extension to northernmost Florida. This extension is not surprising because *C. reznicekii* had been known from southernmost Alabama (Werier 2006).

Florida. Holmes Co.: ca. 0.8 air mi N of junction route 2A and route 185 at Sweet Gum Head, ca. 0.1 mi S of Alabama state line, on McDuffie Road, Gully Branch, 8 Apr 1993, *Orzell & Bridges 21397* (USF).

Carex tonsa var. rugosperma

Carex tonsa var. *rugosperma* inhabits dry-mesic, somewhat nutrient-poor and barren, open forests, forest openings, and forest edges, often in rocky or sandy ground. It had been known to occur from Nova Scotia west to Saskatchewan, south to New Jersey, Ohio, and Illinois, and south in the Appalachian Mountains to Georgia (Crins & Rettig 2002). The record cited below is a westward range extension to southeastern Tennessee. This extension is not surprising, given the previous knowledge of *C. tonsa* var. *rugosperma* in North Carolina, South Carolina, and Georgia (Crins & Rettig 2002).

Tennessee. Franklin Co.: Sewanee, University of the South, ca. 0.3 mi W of Sister Christabel Road, in the Domain, 17 May 2013, *Poindexter 13-123 & Estes* (NCU).

Carex tonsa var. tonsa

Carex tonsa var *tonsa* grows in dry-mesic, somewhat nutrient-poor and barren, open forests, forest openings, forest edges, and stabilized dunes, often in sandy ground. The previously known distribution was Newfoundland west to Labrador, Saskatchewan, and British Columbia, south to Georgia and Missouri (Crins & Rettig 2002; USDA 2015). The specimens cited below fill in gaps for this range for Kentucky and Tennessee.

Kentucky. Lewis Co.: above Hymes Knob Prairie, 28 Jun 1989, *Cusick 28274* (NY). McCreary Co.: 6.1 mi SW of community of Hill Top, 24 Apr 2010, *Naczi 12864* (NY). Madison Co.: Berea, Berea College Forest at Radio Tower Hill, 29 Apr 2011, *Poindexter 11-44 & Thompson* (BOON, NY). Rockcastle Co.: W of Morrill, along Burnt Ridge Road, 29 Apr 2011, *Poindexter 11-50 & Thompson* (BOON, NY). **Tennessee**. Blount Co.: Great Smoky Mountains National Park, Scotts Gap Trail, 4 May 1985, *McNeilus s.n.* (TENN); Great Smoky Mountains National Park, above Lake Chilhowee Watershed, 3 May 2001, *Busemeyer 536 et al.* (TENN). Carter Co.: W of community of Roan Mountain, along route 19E, 12 Apr 2011, *Poindexter 11-09* (BOON, NY). Cocke Co.: Cosby, along Caney Creek Road, 28 Apr 2011, *Poindexter 11-39* (BOON, NY). Johnson Co.: Shady Valley, along route 34 near county line, 26 Apr 2011, *Poindexter 11-34* (BOON, NY). Polk Co.: Ocoee River Gorge (grown in greenhouse and harvested for chromosome analysis from live material originally collected by D. Estes), 17 Jan 2014, *Poindexter 14-05* (NCU).

ACKNOWLEDGEMENTS

We thank curators of the following herbaria for making specimens available for our study, including loans and assistance during our visits: APSC, BOON, FLAS, NCU, NY, PH, TENN, and USF. Ralph L. Thompson assisted with field work in Kentucky.

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ECOLOGICAL CHECKLIST OF THE MISSOURI FLORA FOR FLORISTIC QUALITY ASSESSMENT

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ABSTRACT

An annotated checklist of the 2,961 vascular taxa comprising the flora of Missouri is presented, with conservatism rankings for Floristic Quality Assessment. The list also provides standardized acronyms for each taxon and information on nativity, physiognomy, and wetness ratings. Annotated comments for selected taxa provide taxonomic, floristic, and ecological information, particularly for taxa not recognized in recent treatments of the Missouri flora. Synonymy crosswalks are provided for three references commonly used in Missouri. A discussion of the concept and application of Floristic Quality Assessment is presented. To accurately reflect ecological and taxonomic relationships, new combinations are validated for two distinct taxa, *Dichanthelium ashei* and *D. werneri*, and problems in application of infraspecific taxon names within *Quercus shumardii* are clarified.

CONTENTS

Introduction
Species conservatism and floristic quality
Application of Floristic Quality Assessment
Checklist: Rationale and methods
    Nomenclature and taxonomic concepts
    Synonymy
    Acronyms
    Physiognomy, nativity, and wetness
Summary of the Missouri flora
Conclusion
Annotated comments for checklist taxa
Acknowledgements
Literature Cited
Ecological checklist of the Missouri flora
    Table 1. C values, physiognomy, and common names
    Table 2. Synonymy crosswalk
    Table 3. Wetness ratings and plant families

INTRODUCTION

This list was developed as part of a revised and expanded system for Floristic Quality Assessment (FQA) in Missouri. FQA is a method of assessing the natural integrity and recovery potential of an area based on vegetation, and tracking management response through time (Taft et al. 1997).

Key to deployment of a Floristic Quality Assessment system is a disciplined enumeration of the vascular flora of a region, with a standardized convention for names and acronyms for each taxon. Other attributes for each taxon include whether it is introduced or native to a region, life history traits (physiognomy), degree of predilection for wetland conditions, and a conservatism ranking (C value). The conservatism ranking is an integer between 0 and 10 reflecting the degree of obligate dependence of a taxon on intact natural habitats with direct composition, site conditions, and process regime linkage to the immediate pre-Eurosettlement period. For each taxon, coefficients are assigned based on observed ecological performance, derived from collective extended field experience and empirical observations in the contemporary landscape. Factors influencing C value include disturbance tolerance, habitat affinities, and degree of dependence on intact native vegetation assemblages and their associated site conditions and process regimes.

The concept of species conservatism and Floristic Quality Assessment was first developed by Wilhelm (1977), who applied it at a county level. The system was subsequently modified and expanded by Wilhelm and Ladd (1988). The first FQA system for Missouri was developed by the senior author in 1987 and refined in 1993 (Ladd 1993); this was the first application of FQA at a statewide scale. Since then, FQA systems have been developed for multiple states and provinces (e.g. Herman et al. 1997; Oldham et al. 1995; Rocchio et al. 2013).

SPECIES CONSERVATISM AND FLORISTIC QUALITY

In the New World, native biological systems and their component biota are under intensifying levels of stress. In midcontinental North America, since the peak of the last glacial advance some 15,000 years ago, these systems had persisted for millennia in dynamically stable arrays, supporting an unimaginable diversity of organisms with complex interactions. Today, unprecedented levels of habitat destruction and altered process regimes, such as fire and grazing, have resulted in fragmented, largely degraded systems with reduced ecological function, resiliency, and diversity. These impacts have been exacerbated by the biologically new prevalence of a suite of introduced organisms adapted to the perturbations our sedentary urban/intensive agriculture society has imposed on the landscape.

Native species respond differently to perturbations that are novel to or exceed the magnitude and/or frequency of the post-glacial regimes to which they were attuned. Some species are more facultative and adaptable and can tolerate significant impacts, sometimes even increasing opportunistically in response to post-Eurosettlement disturbances. Other taxa are obligately restricted to the site conditions, associations, and constrained range of process regimes and conditions that characterized the post-glacial, pre-Eurosettlement landscape. If process regimes are altered and degrading impacts occur, these species are typically the least capable of maintaining their viability and are lost from the system. These taxa, once locally expunged from a site, are also least capable of becoming reestablished in the contemporary landscape, resulting in losses of aggregate biodiversity. These losses can further destabilize the system, resulting in cascading effects of further degradation, increasing loss of native biodiversity, and increased vulnerability to invasive species and their deleterious impacts.

This pattern of organismal performance in the landscape reveals two key issues. First, certain organisms are fundamentally linked, spatially and temporally, to pre-Eurosettlement incarnations of ecosystems and are vulnerable to loss from disturbances and perturbations. To the extent that human society considers it a priority to maintain functional, viable examples of natural systems, direct efforts are required to sustain these systems and the most sensitive components of their biota. Secondly, this conceptual spectrum of organismal response to system perturbation and degradation can be used to assess and monitor the degree to which the contemporary environment and human activities are maintaining or degrading system integrity and diversity, particularly among those organisms least able to become reestablished once lost from the system.

This obligate reliance on intact native systems and process regimes prevailing prior to Eurosettlement is called *species conservatism*. Conservatism embodies two interrelated tenants: (1) organisms differ in their tolerance of and response to disturbance, and (2) organisms display varying degrees of fidelity to intact habitats, process regimes, and site continuity. Conservatism can be can be codified along a continuum ranging from species obligately restricted to intact natural systems and process regimes — highly conservative species — to species whose presence is completely uncorrelated, or even negatively correlated, with these factors — non-conservative species. Non-native taxa, because they have no role in native systems, cannot have conservatism and are conceptually excluded.

Organismal performance along this spectrum of species conservatism can be numerically ranked and used to assess overall system condition and performance through time. Assigning an integer value to each taxon of the vascular vegetation, ranging from 0 for species with no inherent conservatism to 10 for species that are fundamentally conservative, results in a valuable tool for gleaning insights into our landscape. Through careful, disciplined assessment of the observed performance of each species in the contemporary environment, these valuations can be assigned by experienced, botanically astute field biologists with a good sense of local ecosystems. The collective response of the components of the vegetation can then be used to derive meaningful information regarding the degree to which the system is maintaining itself, particularly its least replaceable components, through time.

As an example, in Missouri Common Ragweed, *Ambrosia artemisiifolia*, although a native plant that can occur in our finest natural areas (albeit in low numbers), occurs in virtually any habitat, including newly cleared land and highly disturbed environments. This fundamental lack of conservatism results in a conservatism ranking (C value) of 0. At the other end of the spectrum, Epiphytic Sedge, *Carex decomposita*, is restricted to high quality sinkhole ponds with intact hydrological regimes and a consistent suite of obligate wetland associates; once the species and its seedbank are lost from a pond, it is unlikely to become reestablished. This obligate fidelity to intact systems with direct linkage to pre-Eurosettlement site conditions and processes results in a C value of 10.

Within this spectrum, every taxon in the vegetation can be assigned a numerical rating based solely on its observed ecological performance, but exclusive of perceptions of rarity, jurisdictional protection, endangered status, appearance, utility to humans or wildlife, toxicity, or other extraneous factors. In essence, the mind-boggling complexity of the responses of the more than 2000 taxa of native plants comprising our local systems is distilled into 11 different types of plants representing 11 ranks of relative conservatism.

Note that species conservatism is a fundamental attribute independent of natural community type. Many conservative taxa occur in multiple community types, probably at least in part because natural community classification is an attempt to create discrete types among an essential continuum by evaluating post-Eurosettlement examples, with little detailed knowledge about the composition, structure, and dynamics of the original systems.

A simple approach to understanding the concept of conservatism is to consider a C value to represent the degree of confidence that a given plant comes from an area with a high degree of remnant integrity. For example, if presented with a specimen of Common Ragweed (*Ambrosia artemisiifolia*), although it sometimes occurs in high quality sites, one would have no assurance that the plant in hand originated from such an area, since the species also occurs as a ubiquitous weed throughout the contemporary landscape. Since no degree of assurance about the quality of the site is imputed from the presence of this plant, it would receive a C value of 0. On the other hand, if one

were presented with a specimen of Little Bluestem (*Schizachyrium scoparium*), there would be a likelihood that it came from an area with a degree of remnant integrity, although this species is capable of surviving some disturbance and even recolonizing suitable sites. With the potential but not certainty that the specimen was from an area with remnant native diversity and context, it would receive a middle C value, in this case 5. At the other end of the spectrum, the presence of Showy Lady's Slipper (*Cypripedium reginae*) conveys near certainty of habitat integrity, resulting in a C value of 10.

In practice, plants with C values of 0-3 are native weeds and disturbance-adapted plants, displaying high opportunistic potential for occupancy of disturbed sites. These taxa are typically well adapted to the contemporary environment outside of their pre-Eurosettlement system context. Plants with C values of 4-6 are typically matrix species in intact habits, with some limited ability to adapt to disturbance and repopulate areas from which they have been expunged. Plants with C values of 7-10 are considered conservative, with high fidelity to intact habitats.

Because of the complex relationships and interdependencies among biota in intact habitats, an inherent assumption of FQA is that there is a correlation between high quality systems as ranked by their vegetation and high quality and viability among other organismal groups. While this is an incompletely tested and imperfect assumption, in practice it seems to represent a fundamental attribute. In the future, similar ranking systems for other organismal groups, particularly invertebrates, could provide additional insights into this relationship. Essentially, FQA serves as a metric to assess and monitor natural habitats much as a temperature gauge provides information from which one can make assumptions about the function and performance of an engine.

Two misdirected criticisms have been directed toward FQA. The first objects to the perceived subjectivity of the system, arising from the discomfiture of empirical assignment of C values to the flora. In theory, the same relative ranking could undoubtedly be derived in time with sufficient sampling and ordination among data sets, but in practice the expense and time in accomplishing this would be nearly prohibitive. More fundamentally, such criticism fails to account for the fact that all applied systems designed to provide feedback to guide management and conservation efforts are by definition subjective. Recently, Matthews et al. (2015) tested and confirmed the overall consistency and utility that can be derived from assigned C values.

While ecological data are themselves value-neutral, the decision to manage a system for its remnant integrity or to sustain its biota requires subjective assessments as to the desired end state. In most monitoring and assessments, this subjectivity is derived through determining a discrete goal in terms of structure, composition, diversity, or other attributes. An inherent fallacy of this is that we have little detailed information regarding the diversity, composition, structure, or range of dynamism in our native systems, and what data do exist are derived from sites and conditions influenced, passively or actively, by centuries of post-Eurosettlement impacts. Thus, establishing arbitrary goals for desired condition, composition, or end state based on preconceived notions of natural communities risks stressing the system beyond the constrained dynamism to which it is attuned and resilient, with corresponding losses of diversity, particularly among the least replaceable elements of the system. Another risk is that attempts to maximize rare or target species may weaken system resiliency and long term viability.

In FQA, empirical information about the ecological performance of individual species in the contemporary environment is consistent, dispassionate, and preloaded without regard to preconceptions. In essence, it acknowledges that there are large data gaps in our knowledge of native vegetation and that all we can attempt is to carry assemblages of biota through time in self-sustaining interactive arrays, with special consideration for those elements that are most sensitive to loss and that

once lost are least able to be reestablished. Emphasizing a system-level focus as driven by the collective response of the component biota accommodates uncertainties and avoids potentially counterproductive assumptions and insupportably rigid goals.

Another criticism directed at FQA is that an emphasis on conservative species drives management actions towards maximizing conservative species presence, with the unstated corollary that this risks losses in collective system diversity and viability. In practice, the presence of a diversity of conservative organisms depends on a healthy, functional system with a full complement of diversity to ensure system function and viability. Thus, FQA-driven protocols are actually more reflective of long term synecological integrity, resiliency, and system health.

Effective FQA requires incorporation of the full spectrum of an organismal group – in this case vascular vegetation – into the assessment protocol. In turn this requires experienced field practitioners who can identify to species or infraspecific level the elements of the flora at the time of sampling, whether or not they are fertile. Identification only to generic level will prevent effective use of FQA, since many genera (e.g. *Carex, Dichanthelium, Rubus, Symphyotrichum*) include taxa spanning the full spectrum of conservatism. Since many genera in our flora include both native and introduced taxa, generic information alone is essentially useless. To be effective, the development of C values must be conducted in an intellectually rigorous atmosphere exclusively within the region for which FQA is being developed (in this case the state of Missouri), considering the entirety of habitats and regions within the region, without taking into account the distribution and performance of the organism outside of the region.

Inevitably a few anomalous examples occur when evaluating the ecological performance of each element of the flora within a state spanning multiple ecoregions. In some cases, a plant may occur as a native in one part of the state and as an introduced element in another. In these cases, the plant is regarded as native, but its disturbance tolerance and adaptability are reflected in the assigned C value. An exception to this is Black Locust (*Robinia pseudoacacia*), for which there are separate entries and acronyms for native and introduced populations, as explained in the annotated comments preceding the list. In a few cases, for species with limited data regarding their presence in Missouri, or for those that are known primarily from historic data, or for taxa associated with habitats that have been wholly expunged or degraded since settlement (e.g. canebreaks, pineries, sand prairies), placeholder rankings were assigned based on existing data, sometimes with consultation from experts or field biologists from bordering regions. In practice, these taxa will seldom be encountered in assessments.

APPLICATION OF FLORISTIC QUALITY ASSESSMENT

This checklist can be used to apply Floristic Quality Assessment (FQA) to assess floristic integrity in Missouri, using several calculated parameters. The list can be accessed online as a tool for FQA calculations (Freyman & Masters 2013). Parameters derived through FQA include:

1. Native and total diversity (species richness)
2. Mean coefficient of conservatism (mean C value, or $\bar{C}$), and frequency distribution among conservatism classes
3. Floristic Quality Index (FQI)
4. Frequency distribution among physiognomic classes
5. Number and relative composition of native and introduced taxa
6. Relative importance values by taxon and physiognomic class
7. Wetness ratings

Each of these parameters, and their application in assessing and monitoring natural vegetation, is discussed in the following section.

1. NATIVE AND TOTAL DIVERSITY. Species diversity is an important aspect of system integrity and can be analyzed on multiple scales for a given site. Compiling a comprehensive list of the vascular flora of a site provides insights into the universe of taxa that can potentially participate in the vegetation of any given subunit. If quadrat-based or other quantitative sampling is also conducted at the site, some concept of per-unit-area diversity will emerge. The two values together provide coarse information about site integrity: a site with relatively high overall native diversity but very low per-quadrat diversity typically indicates past perturbation but overall *in situ* recovery potential. Sites with low overall diversity and low or moderate per-quadrat diversity likely have limited recovery potential without direct restoration of *ex situ* plant materials, unless there is significant untapped diversity in the seed bank, as occurs in some wetland soils. The presence of large numbers of introduced taxa indicates past impacts and the potential to impede recovery; in practice, high numbers of introduced taxa are also reflected by declines in native diversity, particularly among conservative taxa.
2. MEAN **C** VALUE. This is derived by adding the total C values for all native taxa and dividing by the number of species, $\bar{C} = \Sigma C^{1\cdots n}/N]$, where N is the native species richness. This provides an indication of the degree to which the vegetation has affinities to intact remnants. In practice, a representative 10-acre tract in the majority of the Missouri landscape will have a mean C value below 3; sites with mean C values above 4 have some level of remnant integrity, and levels above 5 are of high conservation significance.
3. FLORISTIC **Q**UALITY INDEX. This is a weighted index of species richness obtained by multiplying the mean C value by the square root of the native diversity [$FQI = \bar{C}(\sqrt{N})$]. This provides a key indicator of vegetation integrity, since it combines both quality and richness. Forty years of assessment work in Midwestern ecosystems have demonstrated that FQI values provide fundamental insights into the diversity, resiliency, and floristic integrity of an area, and that changes in FQI values correlate with meaningful changes in system health and diversity. In practice, increases in FQI documented during restoration efforts in remnant systems typically result from increases in diversity, since mean C values seldom shift significantly. This serves as a back door validation of the concept of conservatism, reinforcing the high fidelity of highly conservative taxa to intact sites, and their irreplaceability once lost from the system.
4. FREQUENCY DISTRIBUTION AMONG PHYSIOGNOMIC CLASSES. By assigning a physiognomic class to every taxon in the Missouri flora, the checklist allows assessments of vegetation by physiognomic class. This can be particularly helpful in monitoring the recovery of degraded systems with remnant floristic integrity that are undergoing restoration. For example, the ground layer of a fire-starved, overgrown woodland such as commonly occurs throughout much of the Ozark region today will have very low levels of graminoid and forb presence, and a proliferation of tolerant woody taxa. This condition strongly contrasts with information about the pre-Eurosettlement character of Ozark woodlands, which are universally described as open and largely brush free, with a prominent graminoid and forb component (Ladd 1991, 2014). With the restoration of an ecologically appropriate fire regime and resulting increased light at the ground level, many of these sites have sufficient remnant diversity to show significant increases in both diversity and presence of grasses, sedges, and forbs.
5. NATIVE AND INTRODUCED TAXA. The checklist designates each taxon growing in Missouri as either native or introduced, allowing rapid evaluation of the proportion of a site's flora that is native. As used here, native refers to those taxa that were a component of the vegetation of the region prior to Eurosettlement of North America, while introduced refers to those taxa that have become established in Missouri after that period. In theory, the presence of a diversity of non-native taxa is not necessarily deleterious to floristic integrity, but in practice this is invariably reflective of physical disturbance or altered process regimes and associated losses among conservative native taxa. Although the presence of introduced taxa may or may

not be directly causing impacts to native vegetation, the ability to track presence and diversity of introduced taxa through time, at both site and quadrat levels, can be a valuable metric for tracking system response, particularly when this information is correlated with other outputs from FQA.

6. RELATIVE IMPORTANCE VALUES. A useful output from FQA is the ability to use quadrat-based or other quantitative sampling methods to assess vegetation composition and response. In addition to information regarding C values and floristic quality indices, information about relative importance provides more nuanced insights into system character and change through time. This can provide feedback about recovery of impacted areas, such as by monitoring the aggregate importance values of native versus introduced taxa, or by assessing the degree to which a few species dominate overall vegetation — usually associated with impacted systems. It should be emphasized that, given the lack of information about prevalence, cover, and dominance relationships among the flora of intact systems, care should be taken to avoid pre-determining "optimum" compositional levels. Rather, importance value data can be tracked in association with FQA and C value data and used to develop insights into the relationship – in effect letting system response tell us the range of conditions under which the collective biota, with emphasis on sustaining the least replaceable elements, can be carried through time in interactive, self-replicating arrays.
7. WETNESS RATINGS. As described later in this work, each taxon in the checklist is assigned a wetness rating largely based on protocols developed to designate jurisdictional wetlands for regulatory purposes (Lichvar 2012). Site floristic inventory data can be used to derive mean wetness ratings for vegetation, resulting in a metric that can be used to delineate sensitive wetlands and also to track aggregate wetness through time. Experience has demonstrated that many native systems become wetter with appropriate restoration and management, as manifested by their vegetation. This presumably reflects the restoration of intact hydrological regimes associated with the increased infiltration and water holding capacity of a rhizosphere characterized by an abundance of deep-rooted perennials.

CHECKLIST: RATIONALE AND METHODS

In establishing a user-friendly FQA system for Missouri, some unique challenges must be surmounted. The last comprehensive single-volume treatment of the Missouri flora, Julian Steyermark's *Flora of Missouri* (1963), is out of print and largely unavailable to modern workers. Recent advances in taxonomy and molecular biology have rendered the nomenclature and taxonomic concepts used in this work outdated for many species and genera and even at the family level. Additionally, several hundred taxa have been added to the state's flora since Steyermark's time. George Yatskievych has recently completed the final volume of his epic *Steyermark's Flora of Missouri* (1999, 2006, 2013), which this list attempts to follow as closely as ecological reality and nomenclatural changes will allow (see below). The intervals between volumes of Yatskievych's work means that some of the species concepts and nomenclature applied in volume one are now outdated, although they are adhered to here unless it would impair the functionality of the application of the list for FQA. Gleason and Cronquist's (1991) regional flora does not include the Ozark region of the state; the Flora of the Great Plains (1986) is similarly incomplete in its coverage for Missouri.

This creates problems for field workers, since there is no single updated source to which they can refer for information on the identification, nomenclature, ecology, and distribution of the Missouri flora. While a simple checklist and database cannot remedy this, derivation of an updated and attributed list of the flora can be a valuable tool for a variety of field workers.

NOMENCLATURE AND TAXONOMIC CONCEPTS

In developing this list, we have attempted as much as possible to remain congruent with the nomenclature and species concepts of Yatskievych (1999, 2006, 2013). Significant deviations from this bear explanation, and are discussed below and in the annotated comments to the checklist.

- Subspecific taxa are recognized only to the extent that they are clearly distinguishable in the field and provide meaningful ecological or distributional information. Use of variety versus subspecies is based on prevailing convention and does not imply judgment as to appropriate level of designated rank.
- The genus *Panicum sensu lato* (including *Dichanthelium*), as treated by Yatskievych (1999) and Freckmann and Lelong (2003), does not accurately reflect the morphological entities, ecological performance, and taxonomic relationships of the group in Missouri. Time and again, morphologically and ecologically distinct and consistent entities are subsumed into broad "species," in the process disenfranchising meaningful ecological information about habitat affinities and distinctness that are of value in assessing vegetation and habitat conditions. Recent studies (e.g. Thomas 2008) and detailed field assessments support maintaining some narrower species concepts within the group. Correspondingly, two nomenclatural combinations are validated here for taxa of *Dichanthelium* that are distinct species from both ecological and morphological perspectives. Both were published in Mohlenbrock (2014) but lacked citation of the basionym reference, rendering them invalid according to Article 41.5 of the ICN (McNeill et al. 2012). We have discussed this with Bob Mohlenbrock and he has agreed to validate the names here, thus both combinations should be cited as "Mohlenbrock in Ladd & Thomas" or simply as "Mohlenbrock."

Dichanthelium ashei (T.G. Pearson ex Ashe) Mohlenbrock, **comb. nov.** *Panicum ashei* T.G. Pearson ex Ashe, J. Elisha Mitchell Sci. Soc. 15: 35. 1898. *Panicum commutatum* var. *ashei* (T.G. Pearson ex Ashe) Fernald, Rhodora 36: 83. 1934. *Dichanthelium commutatum* var. *ashei* (T.G. Pearson ex Ashe) Mohlenbrock, Erigenia 6: 26. 1985. *Dichanthelium commutatum* subsp. *ashei* (T.G. Pearson ex Ashe) Freckmann & Lelong, Sida 20: 169. 2002. **LECTOTYPE**: (Hitchcock & Chase, Contr. U.S. Natl. Herb. 15: 301. 1910 [as "duplicate of the type", corrected in Freckmann & Lelong, Sida 20: 169. 2002]): **USA**. **New York**. Tompkins Co.: Ithaca, Jul 1898, *W.W. Ashe s.n.* (US!; isolectotype: MO!).

Panicum ashei Pearson ex Ashe was maintained as a distinct species until Fernald (1934) included it as a variety within *Panicum commutatum*. Fernald's defense in doing so rests on his finding exceptions to the characters utilized in the keys constructed by Hitchcock and Chase (1910) to distinguish between *P. ashei*, *P. commutatum*, and *P. joorii*. While we agree that the primary characters used to differentiate these three species have occasional exceptions, this does not invalidate them as distinct species; characters in keys being a different matter than the innate nature of the species themselves. This is one of many such groups in the genus that require a close familiarity in the field throughout their range in order to fully grasp the nature and extent of the entities within. The inability to fully describe why a particular taxon is distinct in all cases and at all times does not make it indistinct and the placement of such taxa at an infraspecific rank often detracts from their evolutionary, floristic, and ecological significance.

Dichanthelium ashei typically differs from *D. commutatum* and *D. joorii* by having a more erect habit, with vernal leaves less than 12 mm wide and symmetrical leaf bases. The pubescence characters of the sheaths and internodes for sect. *Commutata*, long perpetuated in taxonomic keys, are not reliable and likely responsible for much of the confusion in this group. *Dichanthelium ashei* occurs in drier habitats than closely related species throughout its range. Several floras, including Freckmann and Lelong (2003), provide adequate keys and descriptions to these taxa, irrespective of rank.

Dichanthelium werneri (Scribn.) Mohlenbrock, **comb. nov.**, *Panicum werneri* Scribn., Ill. Fl. N. U.S. 3: 501. 1898. *Panicum linearifolium* var. *werneri* (Scribn.) Fernald, Rhodora 23: 194. 1921. *Panicum strictum* subvar. *werneri* (Scribn.) Farw., Amer. Midl. Naturalist 11: 44. 1928. *Dichanthelium linearifolium* var. *werneri* (Scribn.) Mohlenbr., Erigenia 6: 26. 1985. **TYPE**: **USA**. **Ohio**. Lake County: Painesville, 1889, *W.C. Werner 60* (holotype: US!)

There has always been uncertainty surrounding this entity, largely stemming from a lack of field familiarity. Clarity is gained when one approaches the group with the understanding that true *Dichanthelium linearifolium* can be glabrous, *D. werneri* can be quite pubescent (including its sheaths) and aside from spikelet length, every other character of *D. werneri* is more similar to *D. depauperatum* than to *D. linearifolium*. This last point was also made by Hitchcock and Chase (1910) but largely ignored by subsequent authors. We discovered this odd relationship while conducting vegetation monitoring in pineland restoration sites across the southern Ozarks of Missouri. Faced with the difficult task of identifying plants in sterile condition, with trial and error we eventually found several solid field characters to distinguish what we were then calling *D. depauperatum* and *D. linearifolium*. Later, when autumnal spikelets emerged, we noted that roughly half of our putative *D. depauperatum* plants lacked the requisite large size and beak of *D. depauperatum* spikelets. Because many of these plants with small, beakless spikelets were glabrous (at least on the sheaths), they would readily key to *D. linearifolium* var. *werneri*. However, since we had become so familiar with their distinct morphological expressions, it was clear that they were distinct from both *D. linearifolium* and *D. depauperatum*. Several years of field work and verification of herbarium material has solidified our concept of *D. werneri* as a consistently distinct species in Missouri. Furthermore, *D. werneri* has more fidelity to high quality acidic woodland communities in Missouri. The following key is based on field characters of Missouri material:

1. Ligule of largest vernal leaves 3-6 times wider than its longest point and usually backed by a pilose adaxial leaf surface; all vernal leaves flattened; leaves thin, green to blue-green, and often distributed on stems above the base of the plant ..... **D. linearifolium**

1. Ligule of largest vernal leaves many times wider than long (thus a short distinct line of hairs) and usually backed by a glabrate adaxial leaf surface; occasional vernal leaves with a distinct rounded "M" cross section; leaves often thicker, deeper green, and strongly basally disposed ..... **D. werneri**

- Even beyond *Dichanthelium*, many concepts of early authors (e.g., Rydberg 1932) seem to reflect valid taxonomic entities with meaningful ecological distinctions. The contemporary trend to minimize the importance of disciplined field work seems often to result in sterile, broadly generalized floristic treatments derived largely or exclusively from herbarium studies, with resultant loss of the essential insights that can only accrue from long familiarity with organisms in their habitats.
- The treatment of *Rubus* in Missouri has undergone a dramatic transformation between Steyermark (1963) and Yatskievych (2013). The current taxonomy better reflects the ecological and morphological entities in the state, and recent field work has begun to elucidate an understanding of the abundance, autecologies, and distributions of these taxa. This is not to say we fully understand *Rubus* but that we have a much better handle on the questions. For many species in the genus, we have included annotated comments that may prove helpful.
- In a few cases (e.g. *Carex tribuloides*, *Strophostyles helvola*), treatment of a species in Yatskievych (1999, 2006, 2013) obscures significant ecological and taxonomic distinctions reflected by the autecological patterns of plants within Missouri. In these instances, we recognize infraspecific taxa that seem to consistently exhibit distinct patterns of morphology, ecology and biogeography, with explanatory annotations.
- Few hybrids are included; their inclusion is somewhat capricious and restricted to fertile hybrids or entities whose presence at a site seems to convey information about habitat ecology or quality.

This is probably somewhat related to the extent to which we have worked with various plant groups and are familiar with their constancy and performance in the field.

Family assignments for each plant largely follow the concepts of Yatskievych (1999, 2006, 2013). Common names are provided for each taxon included in the list. These are an imperfect attempt to provide a standardized usage and eliminate ambiguities. Within these constraints, names are based largely on prevailing use within Missouri. Common names are not duplicated, except for a few pairs of infraspecific taxa that are not typically distinguished from one another by non-specialists.

Synonymy

Entries for each taxon in the list also include information regarding the treatment and names used in each of the following works: Steyermark (1963), USDA Plants (2014), and Yatskievych (1999, 2006, 2013). These cross-references are not taxonomic judgments or sweeping pronouncements on nomenclatural transpositions. They are simply a tool to allow the user to conceptually align names applied among different treatments encompassing the Missouri flora. The synonymy cross-reference is valid only for the individual works cited and may not be valid for the same name used by another author.

An exclamation mark in a synonymy column (i.e., !) indicates that the name in this list is the same as the name used in the reference to which the column refers. If the exclamation mark is in parentheses, this indicates that the names are congruent but that the author, while mentioning the taxon, did not attribute it to the Missouri flora. The designation "in part" in the synonymy columns indicates that the work in question includes what we consider to be multiple taxa under the name cited; typically this relates to infraspecific taxa. In some cases, recent work has revealed multiple taxa that previously would have been conceptually included under the name indicated, even though the names are not technical synonyms.

Acronyms

Each recognized taxon in the Missouri flora is assigned a standardized six-letter acronym. For species lacking multiple infraspecific taxa in the state, the acronym is usually composed of the first three letters of the genus followed by the first three letters of the specific epithet (i.e. "TAROFF" for *Taraxacum officinale*). In cases where multiple taxa would have the same default acronym, non-intuitive acronyms are used to prevent inadvertent recording of the wrong name in the field. Where possible, pneumonic or other aids are incorporated into non-intuitive acronyms (i.e. "ACESIL" for *Acer saccharinum* — **Sil**ver Maple, and "ACESUx" for various infraspecific taxa of **Acer** *saccharum* — **Su**gar Maple). For consistency, the few genera that have non-intuitive acronyms involving their genus names are used consistently for all members of that genus, e.g., all acronyms for *Euphorbia* begin with "EPH" (because of potential acronym overlap with taxa of *Eupatorium*), and acronyms for *Physalis* begin with "PHSA." All *Carex* taxa have acronyms beginning with "CX" instead of the first three letters of the genus.

Species with multiple infraspecific taxa occurring in the state are also coded with non-intuitive acronyms to ensure correct data entry — in most cases these are composed of the first three letters of the genus followed by the first two letters of the specific epithet and the first letter of the infraspecific taxon. Non-intuitive acronyms used in this checklist are designated with a dagger symbol: †.

PHYSIOGNOMY, NATIVITY, AND WETNESS

Each taxon in this list is assigned a physiognomic classification, based on its prevailing life history traits within Missouri (but not necessarily rangewide). These categories are

- annual forb
- biennial forb
- perennial forb
- annual grass
- perennial grass
- annual sedge
- perennial sedge
- fern (including all vascular cryptogams)
- shrub
- tree
- woody vine

Each taxon in the list is further characterized as native or adventive. Native taxa are those that were a part of the pre-Eurosettlement vegetation dynamics in the plant communities within what is now Missouri. Adventive species are those that are not part of any stable native assemblages of vegetation but that have been introduced to the Missouri flora, accidentally or deliberately, since Eurosettlement. These taxa are typically adapted to and in some cases dependent on, the process regimes and perturbations modern society imposes on the landscape.

In some cases, the nativity of a taxon in Missouri is unclear. Changing climate patterns, increased vectors for dispersion, and other factors have resulted in some anomalous patterns of species behavior. These include recent discoveries of southeastern taxa not typically thought of as invasive (e.g. *Cladium mariscus* subsp. *jamaicense*, *Eupatorium album*), as well as recent dramatic increases in distribution of taxa previously considered conservative (e.g. *Eupatorium rotundifolium*, *Tipularia discolor*). In these instances, we have made the designations on a case-by-case basis from an analysis of their ecological performance in Missouri, largely based on field experience, as well as biogeographic patterns and literature data, particularly in light of whether a taxon has a native context or is a regular component of any native vegetation types. A few North American weeds, particularly from areas to the west, may have been introduced to Missouri by Native Americans immediately prior to actual Eurosettlement, but these taxa are typically coded as adventive where they clearly demonstrate the obligate synecological patterns of introduced taxa. Where concepts of nativity in this list differ from Yatskievych (1999, 2006, 2013), explanatory annotation are provided.

Every taxon in the list is assigned one of 5 wetness coefficients, based on Lichvar (2012, 2013) and Lichvar et al. (2014). Wetness coefficients are expressed numerically in odd integers ranging from -5 through 0 to +5; each category has a named designation, as shown below on a scale of decreasing wetness.

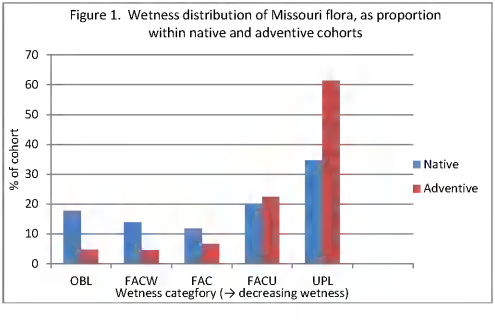
-5	OBL	obligate wetland
-3	FACW	facultative wetland
0	FAC	facultative
3	FACU	facultative upland
5	UPL	upland

For wetland delineation purposes, Lichvar (2012) has divided the continental USA into seven regions. Wetness ratings are assigned to individual taxa within each region. Missouri comprises parts of three of these regions: (1) Atlantic and Gulf Coastal Plain (AGP); (2) Eastern Mountains and Piedmont (EMP); and (3) Midwest (MW). The assigned wetness designations for each of these

regions are provided in Table 3 in ALL CAPS. In instances where a designation was not provided for a taxon in a given region, the wetness designation is provided in small case. Generally, for undesignated entries across all three regions encompassing Missouri, the default rating is upland. For taxa where there is an assigned wetness rating in one or two of the three regions, a default rating is assigned to the other region(s) for consistency.

The final wetness column in Table 3 provides a recommended statewide wetness rating based on each taxon's overall ecological pattern in Missouri. Where different regions encompassing parts of Missouri have different wetness ratings for the same taxon, field knowledge of the plant's habitat proclivities and degree of obligate fidelity to wetlands was used to assign the rating. If this assigned rating falls outside of the range of federally provided ratings for the individual regions, it is included within [brackets]. In these cases the ecological performance for a taxon is notably and consistently different from that provided by its regional wetness rating(s).

Wetness designations often differ inexplicably among adjacent regions, and in Missouri-involved regions some of the recent adjustments to ratings (Lichvar 2013, Lichvar et al. 2014) have not been improvements over the original ratings of Lichvar (2012). For example, *Camassia scilloides*, the comely wild hyacinth of our glades and woodlands, is variously rated as facultative or facultative wetland for the regions that include parts of Missouri, despite its seemingly obligate predilection for uplands throughout its Missouri range. In an even more egregious example, depending on the region within Missouri, *Andropogon gyrans*, a characteristic species of xeric sterile uplands throughout the state, is variously rated upland, facultative, or obligate wetland! One would think that wetness ratings differing so markedly in adjacent regions would trigger skepticism and further inquiry, but such is not the case.



Proportional wetness distribution of the flora, sorted by national wetland rating categories, is shown in Figure 1. This clearly demonstrates the increased wetland affinities among our native flora. Nearly half (43.5%) of the native flora is rated facultative or wetter, whereas only 16% of the adventive component of our flora is similarly adapted to wetland environments.

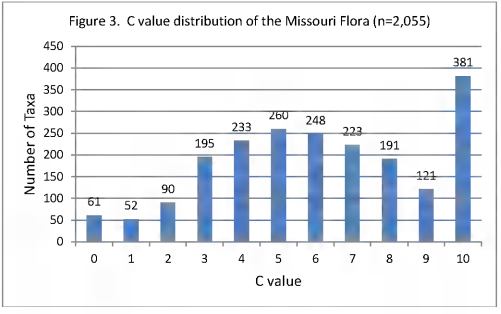
SUMMARY OF THE MISSOURI FLORA

Of the 2,961 vascular taxa comprising the Missouri flora, 906 (30.6%) are considered to be non-native. The physiognomic profile of the native and adventive components of the flora is shown in Figure 2. These data reveal starkly distinct physiognomic patterns between the native and adventive components of the flora. Our native flora, reflecting millennia of constrained dynamism that characterized the post-glacial, pre-Eurosettlement period, is overwhelmingly dominated by perennials: 80% of the flora is composed of woody plants or herbaceous perennials, while only 20% is annual or biennial. On the other hand, fully 50% of the adventive flora consists of annual or biennial herbaceous taxa, reflecting the opportunistic nature of these plants, which are typically adapted to frequent and/or intense disturbance. The most striking difference between native and adventive components of the flora is the disparity in perennial sedges, with proportionally ten times as many native perennial sedges as there are adventives with this physiognomy.

Figure 2. Physiognomic distribution of the Missouri flora by native and adventive cohorts

	Native		Adventive	
Physiognomic Class	#	% of cohort	#	% of cohort
Annual Forb	300	14.6	336	37.1
Annual Grass	43	2.1	65	7.2
Annual Sedge	30	1.5	7	0.8
Biennial Forb	44	2.1	46	5.1
Perennial Forb	904	44.0	239	26.4
Perennial Grass	159	7.7	64	7.1
Perennial Sedge	204	9.9	10	1.1
Fern	73	3.6	2	0.2
Shrub	114	5.5	77	8.5
Tree	145	7.1	47	5.2
Woody Vine	39	1.9	13	1.4
Totals	2,055		906	

Distribution of C values among the Missouri flora are depicted in Figure 3. Nearly half of the flora (45%) can be categorized as conservative, with a C value of 7 or more. Systems with good representation of these taxa are highly restricted in both area and abundance in the fragmented, highly disturbed contemporary landscape, although they presumably were dominant in the pre-Eurosettlement period. The 19% of the flora consisting of plants with low C values (0-3), the native weeds and disturbance-adapted plants, are collectively abundant and disproportionately represented in our modern vegetation, reflecting the frequency and severity of impacts and ecologically novel disturbances that prevail today.



CONCLUSION

An annotated, ecologically-focused checklist of the Missouri flora provides a readily accessible, comprehensive account reflecting the performance of the state's vascular plants in the contemporary landscape. The assignment of C values to each element of the flora allows application of Floristic Quality Assessment tools to inform site assessments, habitat surveys, vegetation studies, and land management decisions.

ANNOTATED COMMENTS FOR CHECKLIST TAXA

This section includes comments and discussions for the individual taxa that are included in the checklist presented in Tables 1-3. Entries are arranged alphabetically by taxon and are referenced in Table 1 by a superscripted triangle (◥) following the species name.

Acer rubrum* var. *trilobum - Distinguished by small, prominently three-lobed leaves with rounded bases; typically occurring as small multi-coppiced trees in upland gravel washes in the southeastern Ozarks and often defining the community type.

Achillea millefolium - Although considered to be introduced in earlier versions of this work, recent evidence indicates that local populations are mostly part of a complex native to North America, although some of our material may be represent Old World escapes.

Agrostis perennans* vars. *aestivalis* and *perennans - Var. *aestivalis* is taller than var. *perennans*, with fewer stems per plant and a lax inflorescence. The spikelets are up to 2 mm long, on pedicels that are 1–3 times longer than the spikelets (in var. *perennans* the spikelets are 2–3 mm long on pedicels no longer than the spikelets). Var. *aestivalis* occurs in high quality shaded wetlands in the Ozarks.

Agrostis stolonifera - This plant is problematic, inasmuch as European strains are widely planted in turf grass mixtures and escape to a broad range of disturbed sites and moisture conditions. However, some of our finest fens and seepage wetlands along streams and spring branches have populations of a smaller, more lax variant of this species, which we are at times inclined to regard as potentially native. It might be more accurate in the future to recognize two elements within in the group, but further study is needed.

Allium canadense* and *A. mutabile - In our experience, *Allium mutabile* is a distinctive species of high quality xeric rocky areas and is characterized by an expanded inflorescence of well-developed

pink flowers and a lack of asexual bulblets. This is in stark contrast to *A. canadense*, which is common in more mesic disturbed/weedy sites and primarily reproduces by asexual bulblets.

Amaranthus blitoides - Although Yatskievych (2006) has suggested this species is native in Missouri, it is not part of any native habitat or vegetation assemblage. All of our populations are associated with severely disturbed sites and are likely introduced from further west.

Amaranthus retroflexus - Although Yatskievych (2006) has implied that this taxon is native in Missouri, various authors regard it as either native or introduced from Tropical America. In Missouri, the plant is almost certainly an introduced weed, occurring only in areas with recent severe disturbance and never found in areas with any level of remnant integrity, in contrast to our native weeds such as *Ambrosia artemisiifolia*.

Anemone acutiloba **and** ***A. americana*** - Although we have followed the prevailing nomenclatural fad, we would strongly prefer using the genus *Hepatica* for *A. acutiloba* and *A. americana*; there are strong morphological reason for doing so, and the original subsumption under *Anemone* (Hoot et al. 1994) reveals paraphyletic relationships that are unresolved by their data. *Hepatica* remains a distinct morphological and molecular lineage, and retention of the genus would more accurately reflect evolutionary and morphological reality.

Apocynum X floribundum - This entity performs ecologically as a distinct species and is perhaps better treated as *A. medium* Greene. It often forms large colonies in woodlands.

Apocynum cannabinum - See notes under *A. sibiricum*.

Apocynum sibiricum - Although subsumed under *A. cannabinum* by Yatskievych (2006) and others, this taxon is distinctive in its sessile to nearly sessile, broadly cordate, subcoriaceous lower leaves, and a predilection for prairie regions, as opposed to the narrower, petiolate leaves and woodland affinities of *A. cannabinum*. Unfortunately, taxonomic concepts in this group have been obfuscated by a predominance of herbarium specimens with only the upper portions of the plant that lack the diagnostic lower leaves. Both Weakley (2011) and Swink and Wilhelm (1994) consider this taxon distinct.

Aristolochia serpentaria **vars.** ***hastata*** **and** ***serpentaria*** - Although regarded as a "trivial variant" by Yatskievych (2006), in Missouri this element is dramatically distinct, with larger, narrowly lanceolate leaves and broadly hastate bases; it appears to be restricted to southeastern Missouri. *Aristolochia serpentaria* is sometimes segregated as the genus *Endodeca*.

Asclepias speciosa - Yatskievych (2006) has speculated that the single St. Louis county record of this western species may be native, but it is adventive in the Chicago region (Wilhelm 1994) and likely also in Missouri, especially as far eastward as St. Louis.

Aureolaria flava **var.** ***calycosa*** - Although subsumed under *A. flava* by Yatskievych (2013), we consider this element to be distinct; it has a larger stature, with narrower, less dissected leaf segments and larger corollas than the typical variety. Var. *calycosa* is the most common element of the species in Missouri, occurring in dry and dry mesic wooded uplands on acidic substrates in the eastern and southern portions of the Missouri Ozarks.

Aureolaria flava **var.** ***flava*** - This taxon is apparently restricted to somewhat mesic, often deeply shaded, woodlands in the southeastern Missouri Ozarks. It has a smaller stature, slightly smaller corollas, and wider, more abundantly dissected leaves than does var. *calycosa*.

Baptisia sphaerocarpa - While Yatskievych (2013) has suggested that some Missouri populations of this attractive and sometimes cultivated native of the south central USA may be native, others are known introductions. It seems more prudent to regard all Missouri material as introduced, as did Steyermark (1963).

Bidens aristosa **and** ***B. polylepis*** - Although Yatskievych (2006) included *Bidens polylepis* within *B. aristosa*, we believe that the two elements are sufficiently distinct that some may wish to recognize

them as separate species: *B. polylepis* with 12 or more coarsely ciliate, often curled, outer involucral bracts usually exceeding the inner bracts, with smaller achenes; *B. aristosa* with typically less than 10 weakly ciliate outer involucral bracts shorter than the inner bracts, with larger achenes. Although they have similar ecologies, *B. polylepis* is the common element in the state; *B. aristosa* appears to be uncommon except in eastern Missouri.

Bidens comosa* and *B. connata - Yatskievych (2013) united these taxa within *B. tripartita*, but locally it seems useful to recognize two entities, both distinct from the European *B. tripartita*, which has white-pubescent outer involucral bracts, as opposed to the glabrate to sparsely ciliate bracts of our native material. *Bidens connata* has 5-lobed, deep golden disk flowers with exserted stamens and achenes with bumpy or hairy midribs; *B. comosa* has 4-lobed, pale yellow disk flowers with included stamens and achenes with smooth midribs.

Calamovilfa longifolia - Missouri records are historical from a few counties along the Missouri River and likely represent introductions from immediately to the west; see Thieret (1966).

Carex aureolensis - As contrasted with the caespitose *Carex frankii*, with setiform pistillate and staminate scales, *C. aureolensis* is a rhizomatous plant with narrowly ovate, awned scales. *Carex aureolensis* is fairly well restricted to forested wetlands in the southeastern quarter of the state. *Carex frankii* is much more common and found in a very wide variety of mostly degraded, wet or moist habitats throughout the eastern United States.

Carex cumberlandensis - This species occurs in southeastern Missouri, growing in mesic woodlands along streams and on lower slopes. It would probably key to *C. abscondita* in Yatskievych (1999) but differs in having distichously arranged perigynia and drooping lower spikes, as contrasted with the spirally arranged perigynia and erect lower spikes of *C. abscondita*.

Carex frankii – See comments under *C. aureolensis*.

Carex laxiculmis* vars. *copulata* and *laxiculmis - Although Yatskievych (1999) did not recognize infraspecific taxa in this species, the two varieties traditionally segregated have distinct morphologies and ecologies. Var. *laxiculmis* is strongly glaucous, with slightly broader leaves (to ca. 12 mm); var. *copulata* is green, with leaves to ca. 8 mm wide. Both taxa occur in high quality mesic woodlands in southern Missouri, but the typical variety seems to be more restricted to sandy floodplains and acidic seeps in the eastern sectors.

Carex missouriensis - This species of prairie swales and wet prairies in the glaciated plains sections of Missouri would key to *C. bicknellii* var. *opaca* (= *C. opaca*) in Yatskievych (1999) but differs in the acuminate or awned tips of the scales, which are whitish or brownish and membranaceous, with the midvein becoming obscure distally; in *C. opaca* the scales are blunt to acuminate, with firm herbaceous tips and prominent midveins extending to the tips.

Carex reznicekii - This species is very similar to *C. umbellata*, to which it would key in Yatskievych (1999). It differs *from C. umbellata* in its lack of basal solitary pistillate spikes. *Carex reznicekii* differs from the similar *C. nigromarginata* in its subequal fertile culms and narrower leaves no more than 2.5 mm wide. It is known from a few mesic to dry-mesic wooded slopes in southeastern Missouri, but it may be overlooked in the state.

Carex timida - Known from recent collections from overgrown dolomite glades in southern and southwestern Missouri, this species would key to *C. jamesii* in Yatskievych (1999) but differs in having staminate scales more than 1.9 mm long and basal sheaths with reddish purple tinges. The beaks of the perigynia are smaller in relation to the body in *C. timida* as compared to the longer beaks of *C. jamesii*.

Carex tribuloides* vars. *sangamonensis* and *tribuloides - In addition to the typical variety, which is common in moist woodlands, especially on floodplains, and has elongate perigynia three or more times longer than wide, there is a distinctive taxon, *C. tribuloides* var. *sangamonensis*, with perigynia

less than three times longer than wide and in tighter heads, that occurs in slightly drier habits than the typical variety and has a more southwestern distribution, though there is significant range overlap.

Carya glabra* and *C. ovalis - Yatskievych (1999) has synonymized *Carya ovalis* with *C. glabra*. While some young individuals or depauperate specimens can be difficult to determine, there are two clear entities in Missouri: *C. glabra*, with tight bark, persistent or partially splitting husks, and leaves consistently 5-foliolate; and *C. ovalis* with scaly or platey bark, fully dehiscent husks, and leaves consisting of seven leaflets. *Carya ovalis* is a characteristic tree of dry acidic woodlands in the Ozarks, growing on sterile ridges and upper slopes, while *C. glabra* tends to occur in somewhat more mesic habitats on lower and midslopes and occasionally along streams.

Carya ovalis – See comments under *C. glabra*.

Cenchrus spinifex - Although only recently documented in Missouri, this is a native component of the sand regions of the Sikeston Ridge in southeastern Missouri, growing in sand prairies and disturbed sandy areas. Although apparently a perennial, it can flower the first season. It is distinguished from *C. longispimus* by the 40 or fewer broad-based spines of the bur, as opposed to the 45 or more acicular spines of the burs of *C. longispimus*.

Chenopodium pratericola - Yatskievych (2006) has considered this species to be introduced in Missouri, but it is likely that some of our sand prairie populations are native. Recent treatments in Illinois, Ohio, and Ontario regard this taxon as native.

Cladium mariscus* subsp. *jamaicense - Although it is tempting to classify the Missouri population as native, we are tentatively considering it to be a recent introduction; see Namestnik et al. (2012).

Cornus amomum* subsp. *obliqua - This taxon is probably better treated as a distinct species: *C. obliqua* Raf.

Cornus foemina* subspp. *foemina* and *racemosa - Although we are following Yatskievych's (2006) treatment of these taxa as subspecies, they seem sufficiently distinct to be treated as species: *Cornus foemina* Mill. and *C. racemosa* Lam.

Crataegus collina - Included conceptually here is *C. spes-aestatum*, which Lance (2014) regards as a hybrid possibly involving *C. collina*.

Crataegus schuettei - Local reports of *C. macrosperma* are tentatively referred here; see discussion on p. 912 of Yatskievych (2013).

Cuscuta obtusiflora* var. *glandulosa - This dodder would key to *C. gronovii* in Yatskievych (2006) but differs in the smaller (to 2 mm long) flowers, as opposed to the 2–4 mm long flowers of *C. gronovii*. It is known from moist sites along streams in the Ozarks, growing on a variety of hosts including *Cephalanthus occidentalis* and *Justicia americana*.

Dichanthelium angustifolium - Absent from both Steyermark (1963) and Yatskievych (1999), this primarily coastal plain species occurs occasionally in dry sandstone habitats of prairies in the western and southwestern Missouri. While *D. angustifolium* is sometimes treated as a subspecies of *D. aciculare*, it is sufficiently distinct in morphology and habitat to warrant its treatment as a species. It grows in small clumps with long-linear leaves equally distributed along the vernal culm. The spikelets are 2.2–2.5 mm long, blunt tipped (like a small *D. oligosanthes*), with slightly attenuate primary glumes. It is most distinct when the previous year's stem can be located because the density and extent to which the nodes fasciculate surpasses any other species in our flora.

Dichanthelium ashei - This is a new combination addressed in the text of this paper. It replaces the name *D. commutatum* var. *ashei*.

Dichanthelium bicknellii - We are using this name in the sense that Steyermark (1963) used *Panicum bicknellii* and Yatskievych (1999) has used *Panicum boreale*. Apparently this morpho-entity arises from hybrid events between members of *Dichanthelium* sect. *Linearifolia* and *D. dichotomum* or *D. ashei*. Those familiar with the combinations can readily place the parentage, though none of them

have ever been validly published. Thus, the name *D. bicknellii* is being used to cover an elaborate and undescribed breeding system until said system gains some element of taxonomic resolution and stability. *Dichanthelium boreale* is a traditional species that occurs outside Missouri's boundaries.

Dichanthelium columbianum - This species is thus far restricted to the sand prairie/woodland communities of the lower Mississippi floodplain in Missouri, where it often occurs as a dominant species. It is one of several species that are found along the Mississippi River as well as the coastal plain of the south, southeast, and the beach/dune communities of the Great Lakes. It is superficially similar to the *D. lanuginosum* complex but grows in much more dense clumps, has a ligule approximately one millimeter long, and lacks pubescence along the central third of the adaxial leaf surfaces of the vernal leaves.

Dichanthelium dichotomum* var. *barbulatum - This variety is by far the more common of the two in Missouri. It can be distinguished by the presence of sparse to dense downward pointed hairs just above the nodes of the vernal stem (bearded nodes). It is very common in upland acidic woodlands and forests. The typical variety is extremely rare in Missouri, has wider leaves, lacks bearded nodes, and occurs in mesic to wet mesic habitats. There is little to no justification for maintaining them as varieties of the same species; they are clearly distinct entities.

Dichanthelium dichotomum* var. *yadkinese - This taxon would be better treated as a distinct species: *D. yadkinense* (Ashe) Mohlenbrock. It differs from the other varieties of *D. dichotomum* in having yellow dots along the sheaths and its larger stature. It was only known from a single location in Missouri, which was destroyed by the Taum Sauk dam failure in 2005.

Dichanthelium implicatum - Steyermark (1963) included this taxon in Missouri as a variety within the *Panicum lanuginosum* complex, while Yatskievych included it in his broad circumscription of *P. acuminatum* var. *acuminatum*. It differs from both *D. lanuginosum* and *D. acuminatum* in having a smaller stature, smaller (narrower and shorter) leaves with a long-villous pubescence along the adaxial surface, a very unique reflexed curvature to the vernal stem leaves in late summer and fall, smaller spikelets, and an affinity to high quality acidic upland woodlands and glades. There is no evidence supporting its inclusion in a broad concept of *D. lanuginosum* or *D. acuminatum*, and doing so obscures the ecological and evolutionary significance of each.

Dichanthelium joorii - This has been a largely overlooked species in Missouri. Because of its intermediate morphology, it initially appears to represent hybridization or introgression between *D. ashei* and *D. commutatum*. However, it forms distinct populations with unique characters throughout eastern, southern, and southeastern North America. It has an erect habit with more evenly distributed leaves than either *D. ashei* or *D. commutatum*. It also tends to branch more and has leaves that are nearly symmetrical at the base and taper to a nearly acuminate tip. Plants tend to be lighter green than *D. ashei* or *D. commutatum* and occur in more mesic habitats than *D. ashei*. Field familiarity with this species alleviates impressions of morphological intermediacy between *D. ashei* and *D. commutatum* and brings resolution to the group.

Dichanthelium lanuginosum - This species is what Steyermark (1963) referred to as *Panicum lanuginosum* var. *fasciculatum*. Yatskievych (1999) utilized a broad concept of the *Panicum acuminatum* complex, the subordinates of which are all treated as species in the present work. Extensive unpublished research by the second author demonstrates that *P. acuminatum*, in the strict sense, is restricted to the coastal plain of the southeastern United States and that *Dichanthelium lanuginosum*, without varietal designation, is the most appropriate name for this very common species. It is found statewide in most habitats, with a particular affinity to disturbed old fields, woodland clearings, and prairies, where it can become dominant.

Dichanthelium lindheimeri - This species is morphologically similar to *D. lanuginosum* but is glabrous throughout except for a few cilia on the margins of the leaf bases. Ecologically, it occurs in much wetter habitats than *D. lanuginosum*, where it can be confused with *D. longiligulatum*. *Dichanthelium longiligulatum* differs in having smaller leaves, a general lack of cilia on the leaf

margins, smaller spikelets, and a string-of-pearls fasciculation effect along the stem in the autumnal form. See also notes under *D. longiligulatum*.

Dichanthelium longiligulatum - This species is usually found along the draw-down zone of ephemeral wetlands and pond margins. It appears to have a proclivity for acidic, sandy and clayey soils, where it grows in densely spaced clumps, with minimal competition from other plants. Being a morphological diminutive within the *D. acuminatum* complex, it is proportionally smaller than other related taxa in most regards. See also notes under *D. lindheimeri*.

Dichanthelium perlongum - This is best treated as a distinct species in Missouri. It is found in high quality prairie and glade communities throughout the state and can be distinguished from other members of sect. *Linearifolia* by its large, blunt spikelets and often ascending inflorescence branches.

Dichanthelium polyanthes - This is better treated as a distinct species instead of as a variety of *P. sphaerocarpon* as in Yatskievych (1999). It is a much larger plant with longer, stiffer leaves, and a denser inflorescence.

Dichanthelium praecocius - This is better treated as a distinct species rather than any of the several lumpings to which it has been relegated within sect. *Lanuginosa*. It can be identified by its short habit, distinctly ascending leaves, precocious axillary inflorescence, and dark, stiff, villous pubescence. It is morphologically most similar to *D. implicatum* and *D. villosissimum*. It differs from *D. implicatum* in having longer spikelets (1.8–2.0 vs. 1.3–1.6 mm) and is restricted to quality prairie remnants (*D. implicatum* is primarily a woodland species). It differs from *D. villosissimum* in having a shorter stature, narrower leaves, shorter spikelets, and a ligule longer than 2 mm.

Dichanthelium villosissimum - This is a fairly common element of high quality acidic woodland and savanna communities in Missouri. It is readily identified by its densely villous pubescence and is also the largest member of sect. *Lanuginosa*. It superficially resembles *D. praecocius* but it is taller, has wider more spreading leaves, and a minute ring of ligule hairs that are visible under magnification.

Dichanthelium werneri - This is a new combination addressed above. It replaces the name *D. linearifolium* var. *werneri*.

Dichondra carolinensis - Despite Yatskievych's (2006) assertion that some Missouri populations are native, there is no supporting ecological evidence to indicate that this recent addition to the flora is anything but a weed spreading from the southeastern states. Weakley (2011) has mentioned the weedy tendencies of this plant throughout its USA range and characterized occurrences north of the region from Florida to Arkansas and Texas as adventive.

Dirca palustris - Yatskievych (2013) recognizes a second taxon in Missouri, *D. decipiens*, supposedly characterized by pubescent twigs, persistently sessile or subsessile flowers, and distinctly lobed (as opposed to scalloped and undulate) calyx margins. We have been unable to reliably distinguish this element, and *D. palustris* is quite variable in this regard, so we consider all Missouri material to be referable to *D. palustris*.

Echinacea angustifolia - This taxon was considered introduced in previous versions of this list, but a recent collection from a high quality loess hill prairie in northwestern Missouri appears to be native. The original St. Louis record cited in Steyermark (1963) and Yatskievych (2006) is still considered to be an introduction.

Eleocharis compressa* vars. *acutisquamata* and *compressa - These two varieties of *E. compressa* are distinct and warrant segregation. Misunderstanding of the distinct infraspecific variants within this species and the *E. tenuis* complex may be the cause of confusion. *Eleocharis compressa* var. *compressa* has distinctly flattened culms whereas var. *acutisquamata* has narrower, subterete culms that are slightly if at all compressed. Variety *acutisquamata* appears to be a species of mesic to wet-mesic prairies in the Glaciated Plains of northern Missouri.

Eleocharis engelmannii - This complex of somewhat weedy tufted annual spike rushes was lumped into *E. obtusa* by Yatskievych (1999), with considerable discussion of the segregates. We are following Smith et al. (2002) and recognizing three species in the complex. The following key will facilitate determination of material in this section in Missouri.

1. Achenes appearing truncate, widest at or near summit, the tubercle broader than high and about as broad as the achene.
    2. Tubercle a low deltoid, to 25% as tall as achene; the summit of the achene curving outward and ± confluent with tubercle base ..... **E. engelmannii**
    2. Tubercle nearly an equilateral triangle, >35% as tall as achene; the summit of the achene incurved under the tubercle base ..... **E. obtusa**
1. Achenes broadly ovate, broadest well below summit, the tubercle higher than broad and notable narrower than the achene.
    3. Tubercles to 0.5 mm wide; scales of spikelet obtuse to subacute ..... **E. ovata**
    3. Tubercles >0.5 mm wide; scales of distal half of spikelet acute ..... **E. lanceolata**

Additionally, *Eleocharis obtusa* var. *jejuna* occurs in Missouri and is included here under *E. obtusa*; it is characterized by its diminutive size, capillary culms and small achenes.

Eleocharis obtusa – See comments under *E. engelmannii*.

Eleocharis ovata - See comments under *E. engelmannii*.

Eleocharis macrostachya – See comments under *E. xyridiformis*.

Eleocharis tenuis* var. *atrata - While we are unsure of the precise nomenclature for the entity, there is a small-stemmed *Eleocharis* in the prairie regions of Missouri that is notably larger, with more longitudinal edges on the culm and darker achenes than *E. verrucosa*.

Eleocharis xyridiformis - Included under most authors' concepts of *E. macrostachya*, this is a distinctive large spike rush with more robust and more conspicuously compressed culms than those of *E. macrostachya*. While the exact relationship to *E. macrostachya* is unknown, the entity merits recognition (Smith et al. 2002), which is currently available only at the species rank.

Elymus churchii - This is a rare species in Missouri and is endemic to the Interior Highlands. It is superficially similar to *Elymus hystrix*, but it has a nodding inflorescence, reflexed lemma awns, and well-developed glumes. It is found in calcareous woodlands in the White River Hills.

Elymus curvatus - Both Steyermark (1963) and Yatskievych (1999) have used the name *submuticus* for this taxon (Steyermark as a species and Yatskievych as a variety of *E. virginicus*). However, when it is used at the rank of species the name *E. curvatus* has priority over *E. submuticus*. This is a very distinct member of the *E. virginicus* complex. It is morphologically distinct in having nodding, usually partially exerted inflorescences and short awn on the lemmas. It tends to occur in open, somewhat weedy/disturbed habitats.

Elymus glabriflorus - We are puzzled that this species continues to be maintained as a variety of *E. virginicus* by many contemporary authors despite the vast morphological, ecological, and phenological differences between them. *Elymus glabriflorus* has a larger, fuller inflorescence that becomes fully exerted from the terminal sheath. The inflorescence of *E. virginicus* is almost always at least partially included in the terminal sheath and has shorter awns on the lemmas. *Elymus glabriflorus* is found in xeric to dry-mesic woodlands, prairies and old fields. *Elymus virginicus* is fairly restricted to mesic floodplain forests and woodlands. Lastly, *E. glabriflorus* blooms a week or two later than *E. virginicus*, which makes it three or more weeks later than *E. macgregorii*, with which it is also sometimes confused (see notes under *E. macgregorii*).

Elymus jejunus - The recent treatment of *Elymus* in the Flora of North America (Barkworth et al. 2007) revives this name as a variety of *E. virginicus*. Once we understood its distinct morphology

and habitat in Missouri's prairies, we began to question its reduction to varietal status under *E. virginicus*. Morphologically, this taxon most closely resembles *E. virginicus* and *E. glabriflorus*. It differs from *E. virginicus* in having exerted inflorescences and a preference for upland, fully exposed habitats. It differs from *E. glabriflorus*, with which it is often syntopic, in its smaller stature and strongly two-ranked inflorescence with appressed spikelets, where *E. glabriflorus* is larger and has more open/bushy inflorescences.

Elymus macgregorii - The description of this new species (Campbell 2000) and the subsequent treatment of *Elymus* in the Flora of North America (Barkworth et al. 2007) have significantly clarified the *Elymus virginicus* complex. *Elymus macgregorii* is a common species which superficially resembles both *E. virginicus* and *E. glabriflorus*. It differs from *E. virginicus* in blooming two weeks earlier, with glaucous leaves and culms and inflorescences fully exerted from the terminal leaf. The inflorescence is also wider due to the longer spreading awns of the lemmas. Both occur commonly, and often together, in mesic wooded floodplains. *Elymus glabriflorus* blooms latest, has exerted inflorescences, and occurs in drier, more open habitats.

Eupatorium album - This southern species has recently been collected in a pine restoration area in the southeastern Missouri Ozarks. It would likely key to *E. semiserratum* in Yatskievych (2006) but differs in the long acuminate phyllaries, as opposed to the obtuse phyllaries of *E. semiserratum*. While Missouri populations could conceivably represent recent introductions, it seems equally plausible that they are remnants from the more open pine woodlands that formerly characterized significant portions of the Ozarks.

Eupatorium torreyanum - Some recent collections from woodlands in southeastern Missouri differ from typical *E. hyssopifolium*, to which they would key in Yatskievych (2006), in being coarser plants with larger leaves at least 5 mm broad, with well-developed marginal teeth, as contrasted with the entire to obscurely and weakly dentate, narrower leaves (to 5 mm) of typical *E. hyssopifolium*. While these may be of hybrid origin, Weakley (2011) provides a good rationale for recognizing certain putative hybrids in this genus as functional species. It is not known with certainty whether Missouri populations are natives or recent introductions, but at this point we are tentatively considering them to be native. The anomalous Wayne County population discussed under *E. hyssopifolium* by Yatskievych (2006) is included here.

Euphorbia ouachitana - This recently described species is known only from extreme southwestern Missouri, and our understanding of its ecology and conservatism is minimal. It has recently been segregated from *E. commutata* (Mayfield 2013), from which it differs by its annual (versus biennial) habit and deeply pitted seeds remaining dark brown and lustrous at maturity.

Euphorbia serpyllifolia - Although Yatskievych (2006) considers one of the Missouri populations "presumably native," there is no evidence to indicate that this plant of open disturbed ground is anything other than an adventive from the Great Plains.

Fraxinus pennsylvanica **vars. *pennsylvanica* and *subintegerrima*** - Although these varieties were not recognized by Yatskievych (2013), we feel they merit segregation. Var. *subintegerrima*, with glabrous twigs, petioles, and rachises, is the common, weedy, silt-tolerant ash along streams and in disturbed floodplains and ruderal areas throughout the state. Var. *pennsylvanica*, with finely pubescent branches, petioles, and rachises, is restricted to higher quality sites mostly in northern Missouri, growing in moist woodlands.

Fraxinus smallii - This tree appears to be common in mesic woodlands, and in Missouri much of what has traditionally been referred to as *F. americana* is probably this species; see Nesom (2010).

Gaura spp. - Despite the current trend of subsuming *Gaura* within *Oenothera*, we are reluctant to submerge such a distinctive, naturally coherent genus, which differs so much from typical *Oenothera*, and for the present are retaining traditional generic concepts in this group

Helianthus petiolaris - Although Yatskievych (2006) considers this species to be native in Missouri, it is likely a recent introduction from further west. While it seems a bit of a stretch to regard our

annual sunflowers as native, as least in the case of *H. annuus* there is a long history of Native American domestication and use in the region prior to Eurosettlement. The case for nativity is weaker for *H. petiolaris*. Despite Yatskievych's (2006) comments that both of these weedy annual sunflowers occur in prairies, these almost certainly reflect early label data when prairie vegetation was more widely distributed in the state and even the verges of roadsides and railroads could be considered to be prairie. Neither plant is a component of any stable native assemblage or habitat, and both require intensive ongoing disturbance to persist.

Helianthus strumosus - We think this entity is a well-defined species of intact wet areas and seepages, possibly persisting as a glacial relict. Much of the confusion discussed by Yatskievych (2006) devolves from the broad morphological variability within *H. hirsutus*. True *H. strumosus* is taller and broader leaved than *H. hirsutus*, and it most often has glaucous adaxial leaf surfaces. Note that we have revised the wetness values to accurately reflect the performance of this species in Missouri; these differ greatly from those assigned by Lichvar (2012).

Heliopsis helianthoides* vars. *helianthoides* and *scabra - We find these two elements to be well distinguished both morphologically and ecologically, with the typical variety more of a prairie and open grassland taxon, and var. *scabra* found in fens, wooded seeps, and other moist shaded areas in the Ozarks.

Heliotropium procumbens - Although Yatskievych (2013) implies that this plant is native in Missouri by not stating otherwise, it is known only from a single recent collection from disturbed open ground and is here regarded as an introduction.

Houstonia longifolia* vars. *longifolia* and *tenuifolia - Due to a simple architecture upon which a high degree of morphological plasticity is expressed, the genus *Houstonia* can be taxonomically difficult. Steyermark (1963) added to the confusion by asserting that *H. longifolia* is the common element, dismissing the findings of Terrell (1959), who included all Missouri material in *H. tenuifolia*. However, based on Steyermark's key, the vast majority of our material falls within var. *tenuifolia*, and the typical variety is quite rare.

Ipomoea coccinea - Although Yatskievych (2006) considered Missouri occurrences to be native, local populations are probably introductions. The species is not part of any high quality natural community, and all populations we have seen are in highly disturbed areas, including weedy thickets along streams, disturbed roadsides and paths, and moist shaded clearings. The plant often becomes preemptively dominant in these sites, much as any invasive weed. It readily spreads from cultivation and becomes naturalized.

Juncus filipendulus - Recently collected in a seepy dolomite glade in Taney County, this species would key in Yatskievych (1999) to *J. marginatus*, but it differs in habitat and in being a small plant with a strict, congested inflorescence and the perianth segments much exceeding the capsules.

Leersia virginica* vars. *ovata* and *virginica - We see two distinct ecological and morphological entities within *Leersia virginica*. Var. *virginica* is a somewhat sprawling to weakly erect plant with smooth to minutely pubescent lemmas; common in moist areas of wooded uplands and other shaded wet places. Var. *ovata* is a more robust, strongly erect plant with bristly ciliate margins on the lemma. It is apparently restricted to wet depressions in high quality woodlands in southeast Missouri.

Lepidium densiflorum - Although Yatskievych (2006) regarded this taxon as native, it invariably occurs only in ruderal or highly disturbed areas, with no native context whatsoever, unlike the closely related *L. virginicum*, which, while also weedy, also occurs in sites with remnant natural integrity. The origins of the plant are unclear and best summarized by Swink and Wilhelm (1994): "The origin of this plant is uncertain; most authors consider it introduced from Eurasia … and Mulligan (1961) regards it as native to the prairie provinces of Canada." Regardless of its origin, our plants behave ecologically like introduced weeds, and are regarded as such here.

Lespedeza frutescens – See comments under *L. prairea*.

Lespedeza prairea - In high quality mesic to dry-mesic prairies in the Osage Plains, we regularly encounter a distinctive *Lespedeza* that is evocative of *L. frutescens* but is more lax, more foliose and more highly branched. This element appears to be restricted to high quality prairies, and to accommodate it we are resurrecting *L. prairea* (Mack. & Bush) Britt., as applied by Rydberg (1932). The leaves of *L. prairea* are often distichously ranked on a strongly leaning stem, with all leaf surfaces directed upward. The leaflets are obovate, as opposed to the broadly oblong leaflets of *L. frutescens*. In *L. prairea*, the inflorescence is more lax, with short calyx lobes typically less than a fourth as long as the pods.

Lindernia dubia* vars. *anagallidea* and *dubia - Many modern authors do not recognize *L. dubia* var. *anagallidea* as distinct from var. *dubia*, but the two taxa are easily distinguished and appear to have different ecologies in Missouri. Var. *anagallidea*, with the pedicels (except the lowest) far exceeding the subtending leaves, is the common, weedy element in wet muddy or sandy areas statewide. Var. *dubia*, with most of the pedicels shorter than the subtending leaves, is less common and more likely to occur in better quality habitats, particularly sinkhole wetlands; it often has smaller flowers and thinner leaves that are somewhat rhombic.

Listera australis - Recently discovered by the second author in a moist, springy woodland in southeastern Missouri, this species would key imperfectly to *Pogonia* in Yatskievych (1999) but has a small pair of opposite leaves at midstem, with a loose terminal raceme of greenish purple flowers, each with a lower lip split into two elongate narrow lobes. Some authors place this species in the genus *Neottia*.

Ludwigia grandiflora - Although Yatskievych (2013) suggest this species is native in Missouri because of the lack of evidence to the contrary on collection labels, it is highly likely the plant is an introduction: USDA (2014) considers all occurrences in the United States to be introductions.

Melica mutica - Recently discovered in a mesic woodland in southern Missouri, this species has spikelets with two fertile lemmas and glumes of similar size and shape, as opposed to *M. nitens*, with each glume in a pair being markedly different, and three fertile lemmas per spikelet.

Monarda punctata* var. *arkansana - Yatskievych (2013) suggests that this taxon may be introduced in Missouri. It is known only from an 1884 collection in the lower Meramec River valley. On the other hand, the Missouri Department of Conservation (2015) lists it as a species of conservation concern. While it may indeed be an early railroad introduction, we are tentatively retaining it as native, although with no great confidence.

Myriophyllum sibiricum - Yatskievych (2013), while acknowledging the recent migration of this species into the state, regards it as native inasmuch as the putative dispersal vector was "natural," i.e., waterfowl. However, in the ecological sense, and as applied in this work, elements of the flora that have become established in the state post-Eurosettlement are regarded as introductions. These taxa are not part of the stable assemblage of interacting biota that characterized the pre-Eurosettlement landscape and as such have the potential to exert destabilizing impacts on native biota. Additionally, it becomes counterproductive to attempt to segregate certain post-Eurosettlement vectors as "natural," given the pervasive alterations and disruptions that have afflicted all aspects of our environment in the past three centuries. Waterfowl populations, behaviors, and movement patterns have been profoundly altered by the myriad artificial ponds, loss of native wetlands, predator changes, and other impacts, and are no more "natural" than other dispersion vectors in the modern environment.

Panicum gattingeri - Yatskievych (1999) included this as a synonym under *P. philadelphicum*. While dwarfed plants are often difficult to discern (Steyermark 1963), there is considerable difference between these species ecologically and morphologically. *Panicum gattingeri* is actually more similar in overall habit to *P. capillare* in its sprawling habit and wide, densely pubescent leaves. The habit of *P. philadelphicum* is more similar to *P. flexile* in its erect habit, with long narrow leaves that, although densely hairy, are not conspicuously so. *Panicum gattingeri* is found in more mesic

disturbed sites like flooded fields and gravel bars. *Panicum philadelphicum* is a species of upland habitats ranging from disturbed fields and roadsides to high quality glades and woodlands.

Panicum longifolium - This addition to the Missouri flora has been treated as a subspecies or variety of *Panicum rigidulum*. Typical *P. rigidulum* is common in Missouri, growing in disturbed, open, seasonally wet areas and often forming extensive populations with other weedy species. While *P. longifolium* is morphologically similar to *P. rigidulum,* it is smaller, has a more open inflorescence, and is only found in high quality wetlands with other species indicative of stable, often relictual, communities.

Parthenium hispidum - Although Yatskievych (2006) relegates this to a variety of *P. integrifolium*, the two taxa are quite distinct in Missouri, both ecologically and morphologically. Problems as discussed by Yatskievych emanate primarily from attempting to study material only in herbaria and not in the field. *Parthenium hispidum* is a characteristic species of carbonate glades and woodland openings in circumneutral soils. It is strongly rhizomatous, forming dense stands of stout, low stems. The leaves often are somewhat broader in relation to their length compared to those of *P. integrifolium*. *Parthenium integrifolium* occurs as scattered individuals in a wide array of shaded to open dry sites. The somewhat lustrous, dark green leaves are widely scattered along the tall, erect culms.

Penstemon cobaea* vars. *cobaea* and *purpureus - Although these two elements may be, as Yatskievych (2013) states, "trivial color forms," they display distinctive ecological affinities. Variety *purpureus* is restricted to carbonate glades, growing on dolomite and limestone in southwestern Missouri. Variety *cobaea* is a prairie species of the Great Plains, barely extending into the prairies of western Missouri.

Phragmites australis* subspp. *americanus* and *australis - Both a native element and an aggressive Old World element of *Phragmites australis* occur in Missouri. The native subsp. *americanus* is characterized by ligules more than 0.4 mm long and first glumes of the larger spikelets more than 4.5 mm long; the culms are typically tingled purplish. This element occurs in wetlands, coexisting with other wetland species. The weedy subsp. *australis* has ligules to 0.4 mm long, with the larger first glumes seldom exceeding 4.5 mm; the culms are greenish to yellowish. This is the tall, aggressive weed that forms dense monocultures in disturbed wet areas, especially in acidic or saline sites such as strip mine spoils, ditches along slated roads, and industrial areas.

Polygonum ramosissimum* vars. *prolificum* and *ramosissimum - Yatskievych (2013) discusses in detail some of the taxonomic and distribution issues regarding var. *prolificum*, a species of saline seeps characterized by a blue-green cast and smaller, narrower leaves. We regard this element as sufficiently distinct, both morphologically and ecologically, to warrant recognition.

Portulacca oleracea - Long considered an Old World weed, recent works (e.g. Matthews 1993) suggest that this species was used by Native Americans in the pre-Eurosettlement era. Matthews (1993) noted that Nuttall reported this species from Missouri "before settlers could have transported it from the east." Despite this, in Missouri this plant displays the classic attributes of an introduced weed and is not part of any native community phase, including naturally disturbed areas favored by our native weeds.

Potentilla simplex - Although we have decided reluctantly not to segregate it at this point, a distinct phase of this species occurs in our prairies and can be segregated as var. *argyrisma*. It is characterized by striking, appressed, silvery pubescence on the undersides of the leaves and long spreading hairs on the stems.

Proboscidea louisiana - This species of the southern plains has been cultivated as a garden curiosity for centuries, and it is far more likely that Missouri populations, which are uncommon and evanescent, are garden escapes rather than some native range extension carried by bison, as some have speculated.

Prunus hortulana - The subsumption of *Prunus munsoniana* under *P. hortulana* is baffling and seems predicated solely on herbarium analyses by those unfamiliar with the species in the wild. In Missouri the two are distinct and consistent, and regardless of the putative hybrid origins of *P. munsoniana*, it occurs as an ecologically and morphologically distinct entity with strong prairie affinities, forming clonal thickets, as opposed to the more ubiquitous and somewhat weedy *P. hortulana*, which typically grows as a small tree in old pastures and weedy brush rows. The leaf characters described in Steyermark (1963) are also useful for distinguishing the two.

Prunus munsoniana – See comments under *P. hortulana*.

Quercus rubra - What we refer to as *Quercus rubra* has two expressions throughout its range. In more acidic soils and at higher elevations *Q. rubra* often grows straighter, has grayer bark, deeper lobes, and pubescent tips on buds. These trees can be difficult to distinguish from *Q. coccinea* (especially in the White River Hills). This is what authors have variously referred to as var. *ambigua*, var. *borealis*, and even *Q. borealis*. Virtually every key that has been used to separate the two uses proportions of the acorn cap as the primary character, which is ineffective. By comparison, typical *Q. rubra* occurs on more basic soils, has a subtly sinuous trunk with contrasting black and white furrows on the bark, has shallower leaf lobes, and lacks pubescence on the tips of buds. Because we are uncertain as to whether these differences constitute clinal variation or actual segregates of separate breeding systems, both entities are subsumed under *Q. rubra*.

Quercus shumardii* var. *acerifolia - The epithet *acerifolium* was long applied to an element thought to be endemic to the region near Magazine Mountain, Arkansas. But even on Magazine Mountain many of the trees include foliage that has both well-defined maple-like leaves as well as leaves more traditionally associated with what has been referred to as *Q. shumardii* var. *schneckii* and even typical *Q. shumardii*. Also, the extreme morphologies found on Magazine Mountain have recently been found on calcareous glades throughout the Missouri Ozarks, where they clearly grade into what has long been called *Q. shumardii* var. *schneckii*. It seems clear that there is a single taxon of the upland variant of *Q. shumardii*, and some individuals of this element have a predilection to reduced, maple-like leaves, particularly on dwarfed trees of exposed upland sites. This convoluted relationship prompted the second author to compare the morphology of the type specimen *of Q. schneckii* Britton with specimens collected in the field. He was surprised to find that the type specimen of *Q. schneckii* is clearly *Q. texana* and not a member of the Q. *shumardii* complex *sensu stricto* (the type of *Q. schneckii* can be viewed on tropicos.org). Thus, the epithet *"schneckii"* has been misapplied for decades. The next available name for the entity in question is var. *acerifolia*. So, in a strange twist of irony, in finding little evidence to support the maintenance of *Q. shumardii* var. *acerifolia* as a distinct taxon, we now must broaden the name to include everything that has been erroneously called *Q. shumardii* var. *schneckii*.

Rhynchospora scirpoides - Recently discovered in a sinkhole pond in Shannon County, this species would key to *Rhynchospora* in Yatskievych (1999) but would not be determinable to species, since it lacks perianth bristles. It is a tufted annual with only a single empty scale in each many-flowered spikelet; this species was formerly placed in the genus *Psilocarya*.

Robinia pseudoacacia - Although distinctions are not typically made for taxa that have both native and introduced populations in the state, in part because it can be difficult to determine with certainty the origins of a particular population. However, an exception is made in the case of *Robinia pseudoacacia*. Throughout the state, introduced populations of this plant are aggressive introduced weeds, forming dense clonal groves to the virtual exclusion of other vegetation. It can be a problematic weed once established in areas with remnant natural quality. On the other hand, native populations of this species occur at the northeastern edge of their range in extreme southwestern Missouri. Here *Robinia* grows as innocuous understory trees scattered in dry rocky woodlands, with such associates as *Sapindus saponaria*, and displays no tendencies to form thickets or become

aggressive. It would be illuminating to study the genetics of this species in Missouri – our native material may differ significantly from the ubiquitous weedy genotype.

Rosa carolina* subspp. *carolina* and *subserrulata - The *Rosa carolina* complex is poorly understood locally and seems to be bafflingly confounded with *R. arkansana*. Ozark populations in particular are hypervariable and appear to display varying degrees of introgression with other species, perhaps *R. foliolosa*. These Ozark populations are clearly distinct from the low rose that is frequent in remnant prairies in the Osage Plains and Central Tallgrass Prairie regions of the state; they may represent an endemic taxon.

Rubus ablatus - The only way this species makes sense in the field is if it and the name *R. argutus* are switched in Yatskievych's (2013) keys. *Rubus ablatus* appears to be a small to medium blackberry that, in open areas, grows high–arching canes up to 2.0 meters tall. However, in forested habitats it arches low on very wiry stems. Plants of intermediate forms are common. This morphological plasticity in varying degrees of shade makes it difficult to gain a field concept of this taxon. We have also found it to root at the tip, which makes us wonder if we are not actually dealing with *R. recurvans* instead. It is rather distinct in its narrowly elliptic leaves that taper to the tips and taper, or are rounded, at the bases (not subcordate as in the similar *R. argutus*). This does not appear to be very common throughout the state. The distribution maps of *R. argutus* in Yatskievych seem to match it as well.

Rubus alumnus - This is a common species in the Ozarks and can be readily identified by the presence of glandular hairs on the flower and leaf stalks and by the ovate terminal primocane leaves. Caution should be employed because the less common *R. rosa* also has this combination of features, although it is much more glandular and has very large, nearly rotund, leaflets.

Rubus argutus - As stated under *R. ablatus*, this taxon only makes sense if its name has been switched with *R. ablatus* in Yatskievych's (2014) keys. This is the most common blackberry in the state. It can occur in a large range of habitats but is most often found in disturbed old fields, the margins of gravel roads, and heavily burned woodlands/forests. It forms very large patches that often exceed 2 meters tall. It lacks glandular pubescence and the terminal leaflet of the primocane leaves, which is usually broadest at or above the middle, is cordate to subcordate at the base. It is most similar to *R. laudatus,* which differs in having a strongly acuminate terminal leaflet and a propensity to dry a tobacco-brown color.

Rubus celer - This dewberry is very similar to *R. enslenii* but differs in its preference for slightly more mesic sites, more rounded leaflets with more uniform marginal teeth, its tendency to grow as large multi-stemmed plants, and to occasionally form very large tangled populations.

Rubus curtipes - This is typically the most diminutive species of *Rubus* in our flora. The stems of this dainty dewberry often grow in a hoop-like form, with the tip rooting. The primocane leaflets are subtly pubescent beneath as compared to the glabrate leaflets of *R. enslenii* and the densely felty leaflets of *R. meracus* and *R. roribacus*. The floricane leaflets are small and round–tipped and are evocative of *Potentilla canadensis* (although there are only three leaflets). It appears to be fairly common, with an affinity to old fields with other native vegetation.

Rubus enslenii - This is the most common dewberry in the woodlands and forests of the Ozarks. The flowers tend to occur in solitary inflorescences, but robust plants can break this rule. It is also a common component of both the glaciated and unglaciated prairie regions in Missouri. It can be recognized by its glabrate lower surfaces of the leaflets, elliptic terminal leaflets, and a tendency to be very low arching to fully procumbent. Characteristic habitats include xeric to dry-mesic woodlands, forests and prairies, as well as old fields and disturbed open areas. See also notes under *R. plicatifolius*.

Rubus flagellaris - This species is common in the prairie regions of the state and occasional in the Ozarks. The keys in Yatskievych (2013) indicate that it is not pubescent on the lower surfaces of the primocane leaflets. However, there is a tremendous amount of variation in this character and many

specimens will not key by this character. It is typically a low, sprawling dewberry with thick, heavily armed stems that often develop five large leaflets on the primocane leaves. The terminal leaflet is often rotund to broadly ovate and comes to an abruptly acuminate tip. The base of the terminal leaflet is either rounded or subcordate. The leaflets are often coriaceous and longitudinally undulate along the secondary veins.

Rubus frondosus - After *R. argutus*, this appears to be the most common blackberry in the state. It is similar to *R. argutus* except for the broadly ovate terminal leaflets of the primocane leaves. They are widest at or just below the middle of the leaf, where *R. argutus* is typically widest above the middle. *Rubus frondosus* also tends to be a softer plant in terms of thinner and more softly pubescent leaves. Its habitat is the same as *R. argutus*.

Rubus laudatus - This species is similar to *R. argutus* but it has more uniformly serrate teeth on its primocane leaves, shorter acuminate tips of the terminal leaflet of the primocane leaves, and a propensity to dry a tobacco-brown color. Having only found it in fens in the Ozarks and along shrubby swales in the prairie regions of the state, it appears to prefer mesic to wet soils.

Rubus meracus - We are finding a tremendous amount of variation in what keys to both *R. meracus* and *R. roribaccus*. The variation is so rampant that it appears that there are several species encompassed by these two names. Specimens that key to these two names in Yatskievych (2013) should do so because they are softly pubescent with felt-like hairs on the lower leaf surfaces. Specimens that are merely pubescent, but not felt-like softly pubescent, should be keyed under the "not pubescent" lead.

Rubus missouricus - This species has only been found in average to high quality prairies in Missouri. It is easily identified by its small stature (typically waist high or lower) and its propensity for plants to occur as individual floricane-primocane pairs, each separated by a meter or more within what can be quite extensive colonies. It usually produces small blackberries that are not very flavorful.

Rubus mollior - This is a frequent to locally common species in the Ozarks. It is more lax in growth form than most blackberries. It often forms loose mounds of tangled canes. The terminal leaflet of the primocane leaves range from round to obovate with a strongly acuminate tip. The stems and abaxial leaf surfaces often appear subtly glaucous. The inflorescences are short leafy racemes.

Rubus plicatifolius - This species was not officially included in the flora of Missouri by Yatskievych (2014), although he mentions a possible historic record. Recently, several separate investigators working in prairies in the unglaciated region of Missouri began noticing a dewberry that consistently had too many flowers per inflorescence and with the leaf margins too jagged to be *R. enslenii*. The leaves of this dewberry were too elliptic-leaved to be *R. flagellaris* and not sufficiently pubescent to fit into the *R. meracus/roribaccus* group. Because this entity had conspicuously plicate primocane leaflets and otherwise matched the description, the name *R. plicatifolius* was adopted for it. It is superficially similar to *R. enslenii* and the two often grow syntopically with *R. flagellaris*. To date, it has only been found in the glaciated and unglaciated prairie regions of Missouri.

Rubus roribaccus - See notes under *R. meracus*.

Rubus satis - This is another species name that likely encompasses multiple cryptic taxa in Missouri. Though *R. satis* is technically included in the dewberries (sect. *Flagellares*) because of its ability to root at the tip, it has several features that make it different from all other members of the section. For example, plants achieve the size and arching height of blackberries. The mature floricanes turn a reddish mahogany color and have sparsely distributed tiny prickles. In the southeastern Ozarks, *R. satis* has deep green, nearly rugose, primocane leaflets with somewhat revolute margins. In the northern Ozarks as well as prairie regions it more closely resembles an erect-arching *R. flagellaris*. The reddish stem with small prickles and short inflorescences seem to unite these otherwise hypervariable morphologies.

Rudbeckia bicolor - *Rudbeckia bicolor*, long considered synonymous with *R. hirta*, appears to us to be a distinct species of xeric acidic sites in southern Missouri. It is a taprooted annual without basal

leaves, usually growing as a small, single-stemmed plant with no to a few, short, ascending branches. The culm leaves are spatulate to narrowly obovate and apically obtuse, with notably stiffer hairs. In Missouri, *R. hirta*, while capable of flowering the first year and functioning as an annual, is typically a short-lived perennial and has distinct tufts of basal leaves and ovate, apically acute culm leaves.

Rudbeckia fulgida* vars. *sullivantii* and *umbrosa - Campbell and Seymour (2013) have recently completed a preliminary revision of this group; they recognize var. *sullivantii* as a distinct species, and our var. *umbrosa* is referable to their *R. palustris*. Additionally, there is a third taxon in Missouri, which Campbell and Seymour call *R. speciosa* [not fully synonymous with *R. fulgida* var. *speciosa* of Steyermark (1963), much of which is actually referable to *R. fulgida* var. *sullivantii* as applied in this list]. We have little direct knowledge of this third element, even as to whether it is native or introduced, so are not including it on the list at this point. It is characterized by earlier flowering (ca. midsummer), with narrower, less distinctly petiolate leaves that are softly pubescent, as opposed to the late summer to autumnal flowering and broader, distinctly petiolate, coarsely pubescent leaves of the other two members of the complex. A smaller leaved plant with more and shallower teeth on the leaves that is closely related to *R. speciosa*, *R. tenax* C.L. Boynt and Beadle, may be what has appeared with newly installed gravel associated with the remediation of the reservoir failure at the power generation facility on Taum Sauk mountain; it is not yet known whether this will persist as an element of the flora.

Rudbeckia hirta – See comments under *R. bicolor*.

Schizachyrium scoparium - The segregation of this archetypical tallgrass prairie species into a separate genus from other bluestems, while widely accepted, seems inappropriate and unsupported. The generic delimitation is essentially based on the sole character of a single raceme at the peduncle summit, as opposed to two or more in *Andropogon,* despite the compelling morphological similarities in the distinctive spikelets of the complex. Indeed, the morphological differences distinguishing *A. gerardii* from other local members of the genus exceed the degree of difference between *Schizachyrium scoparium* and our other species of *Andropogon*. While we are bowing to convention for the convenience of the user, given the tenuous supporting data for this segregation, we recall Hans Christian Andersen's 1837 work: "But the emperor isn't wearing anything at all"!

Scirpus rubricosus - Although included within *Scirpus cyperinus* by most authors, this taxon appears quite distinct in Missouri. It is characterized by larger, more abundant, pedicillate spikelets on exposed leggy inflorescence branches. Ecologically it is very much like *S. cyperinus*, with which it can be syntopic, but is often found is higher quality wetlands.

Solidago altissima - The common weedy goldenrods remain conceptually confused. The most common weedy form throughout the state appears to be *S. canadensis* var. *hargeri,* despite the implication by the range maps in Yatskievych (2006) that it is less common than *S. altissima*, although both taxa are often common components of old fields, pastures, and other moderately disturbed sites. *Solidago altissima* var. *gilvocanescens*, which has more affinities to prairie vegetation, would seem to be better treated as a subspecific taxon within *S. canadensis*.

Solidago canadensis – See comments under *S. altissima*.

Solidago nemoralis* vars. *nemoralis* and *longipetiolata - In addition to the characters used to distinguish the two infraspecific elements discussed in Yatskievych (2006), var. *longipetiolata* consistently blooms ca. two weeks earlier than the typical subspecies, has longer spatulate leaves, larger flower heads, and is a taller plant. Because var. *longipetiolata* is a fertile polyploid that does not backcross to the parental *S. nemoralis* var. *nemoralis*, one wonders why these are not treated as distinct species. Not doing so calls into question the purported commitment to a biological species concept over a morphological one.

Solidago speciosa* var. *rigidiuscula - This appears to be the common form in prairies, whereas the typical variety has woodland affinities.

Stenosiphon linifolius - As with *Gaura*, we cannot bring ourselves to embrace the nomenclatural trend to subsume this distinctive taxon within *Oenothera*, and so are retaining this species in *Stenosiphon*.

Strophostyles helvola* vars. *helvola* and *missouriensis - Two elements within this species seem sufficiently distinctive morphologically to merit segregation at the varietal level: var. *helvola*, with the leaflets typically lobed or with their margins irregularly incurved and asymmetrical, and var. *missouriensis*, with unlobed, longitudinally symmetrical leaflets and larger fruits and seeds. The latter variety is less common and has often been confused in the field with *S. umbellata* and/or *Amphicarpaea bracteata*.

Symphyotrichum pilosum* var. *pringlei - Although many authors recognize only a single variable element within this species, in addition to the hairy weed that is ubiquitous in disturbed areas throughout the state, there is a smaller, thinner-stemmed, more delicate plant with narrow glabrous leaves that occurs in disturbed areas of rocky wooded uplands, such as along logging roads and skid landings. With absolutely no confidence as to taxonomic accuracy, we are segregating this distinctive element as var. *pringlei*.

Vernonia baldwinii - Note that Yatskievych (2006) has transposed the characters in the key to infraspecific taxa; thus in his keys, subsp. *interior* would key as subsp. *baldwinii*, and vice versa.

Viola nephrophylla - As applied in Missouri, this concept seems to encompass two entities – one a common weed of shaded lawns, low picnic areas, and moist disturbed woodlands, and the other a conservative taxon restricted to fens, seeps, and other high quality minerotrophic or phreatic wetlands, but further study is needed to clarify this issue. Taxonomy of the weedy blue violets affiliated with the *V. sororia* complex remains a tangled mess.

ACKNOWLEDGEMENTS

We are grateful to the many people who have shared their floristic knowledge and provided insights, comments and suggestions since the first iteration of an FQA system for Missouri in 1987; doubtless some have been omitted from this list, for which we apologize. For their insights, comments, and suggestions, we extend our appreciation to Kelly Allred, Randy Arndt, Mike Arduser, Keith Bennett, Daniel Boone, Mike Currier, Carol Davit, Dan Drees, Henry Eilers, Susan Farrington, Craig Freeman, Kanchi Gandhi, John George, Jenny Grabner, Rick Gray, Greg Gremaud, Jacob Hadle, Jack Harris, Hilary Hayley, Blane Heumann, Rex Hill, Nels Holmberg, Mike Homoya, Randy Jensen, Deborah Ladd, Ron Lance, Mike Leahy, Paul Mackenzie, Ken McCarty, Linda Masters, Elizabeth Middleton, Robert Mohlenbrock, Nancy Morin, Caleb Morse, Tom Nagel, Scott Namestnik, Paul Nelson, Guy Nesom, Tim Nigh, Paul Redfearn, Anton Reznicek, Larry Rizzo, Bruce Schuette, Mike Skinner, Tim Smith, Bill Summers, John Taft, Dana Thomas, James Trager, the late Joanna Turner, Malissa Underwood, Allison Vaughn, the late Ed Voss, Alan Weakley, Amy Hepler Welch, Theo Witsell, and Josh Wibbenmeyer.

Special thanks are extended to Gerry Wilhelm for three decades of ongoing collaboration and discussion regarding his concept of species conservatism and FQA; Gerry has been instrumental in our development of the 1987, 1993, and current versions of the Missouri database. George Yatskievych has unstintingly shared his expertise and assisted with myriad queries regarding nomenclatural, taxonomic, and distributional issues; his books provide the modern foundation upon which this work is based. Rex Hill developed software applications for earlier versions of the list, and has been helpful throughout the process. We extend our deep appreciation to Cindy Pessoni for her years of assistance with this project and her consummate skills in editing, organizing, and managing data and spreadsheet analyses.

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ECOLOGICAL CHECKLIST OF THE MISSOURI FLORA

TABLE 1.
Scientific and common names, acronyms, C values, and physignomy for the Missouri flora, arranged alphabetically by scientific name. See discussion in text for more information. Scientific names for introduced taxa are rendered in ALL CAPS and have an asterisk in the C value ("C") column. Non intuitive acronyms are designated with a dagger (†). Taxa designated with a superscripted triangle (◂) following the scientific name are discussed in the annotated comments in the text above.

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ABUTHE	*	ABUTILON THEOPHRASTI	Ad A-FORB	Velvetleaf
ACAANG	10	Acaciella angustissima	Nt SHRUB	Prairie Acacia
ACADEA	7	Acalypha deamii	Nt A-FORB	Large-Seeded Mercury
ACAGRA	3	Acalypha gracilens	Nt A-FORB	Slender Mercury
ACAMON	3	Acalypha monococca	Nt A-FORB	One-Seeded Slender Mercury
ACAOST	1	Acalypha ostryifolia	Nt A-FORB	Three-Seeded Mercury
ACARHO	1	Acalypha rhomboidea	Nt A-FORB	Rhombic Copperleaf
ACAVIR	2	Acalypha virginica	Nt A-FORB	Virginia Mercury
ACEGIN	*	ACER GINNALA	Ad TREE	Amur Maple
ACENEG	1	Acer negundo	Nt TREE	Box Elder
ACERUD†	8	Acer rubrum var. drummondii	Nt TREE	Drummond's Maple
ACERUR†	5	Acer rubrum var. rubrum	Nt TREE	Red Maple
ACERUT†	6	Acer rubrum var. trilobum◂	Nt TREE	Trident Maple
ACESIL†	2	Acer saccharinum	Nt TREE	Silver Maple
ACESUF†	6	Acer saccharum subsp. floridanum	Nt TREE	Southern Sugar Maple
ACESUN†	5	Acer saccharum subsp. nigrum	Nt TREE	Black Maple
ACESUG†	5	Acer saccharum subsp. saccharum	Nt TREE	Sugar Maple
ACESUC†	5	Acer saccharum subsp. schneckii	Nt TREE	Velvety Sugar Maple
ACHMIL	1	Achillea millefolium◂	Nt P-FORB	Yarrow
ACHPTA	*	ACHILLEA PTARMICA	Ad P-FORB	Sneezewort
ACHJAP	*	ACHYRANTHES JAPONICA	Ad P-FORB	Japanese Chaff Flower
ACMOPP	8	Acmella oppositifolia	Nt P-FORB	Spilanthes
ACMAME	6	Acmispon americanus	Nt A-FORB	Clement's Prairie Trefoil
ACOUNC	10	Aconitum uncinatum	Nt P-FORB	Southern Monkshood
ACOCAL	*	ACORUS CALAMUS	Ad P-FORB	Sweet Flag
ACTPAC	8	Actaea pachypoda	Nt P-FORB	White Baneberry
ACTRAC	7	Actaea racemosa	Nt P-FORB	Black Cohosh
ACTCHI	*	ACTINIDIA CHINENSIS var. DELICIOSA	Ad W-VINE	Dwarf Kiwi
ADICAP	10	Adiantum capillus-veneris	Nt FERN	Venus-Hair Fern
ADIPED	6	Adiantum pedatum	Nt FERN	Maidenhair Fern
ADOANN	*	ADONIS ANNUA	Ad A-FORB	Blood Drops
AEGCYL	*	AEGILOPS CYLINDRICA	Ad A-GRASS	Goat Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
AESIND	*	AESCHYNOMENE INDICA	Ad A-FORB	Indian Jointvetch
AESRUD	*	AESCHYNOMENE RUDIS	Ad P-FORB	Zigzag Jointvetch
AESGLG†	5	Aesculus glabra var. glabra	Nt TREE	Ohio Buckeye
AESGLT†	5	Aesculus glabra var. arguta	Nt TREE	Ohio Buckeye
AESPAV	7	Aesculus pavia	Nt TREE	Red Buckeye
AGAASP	10	Agalinis aspera	Nt A-FORB	Rough False Foxglove
AGAAUR	10	Agalinis auriculata	Nt A-FORB	Eared False Foxglove
AGAFAS	7	Agalinis fasciculata	Nt A-FORB	Fascicled Agalinis
AGAGAT	7	Agalinis gattingeri	Nt A-FORB	Round-Stemmed False Foxglove
AGAHET	10	Agalinis heterophylla	Nt A-FORB	Prairie False Foxglove
AGAPUR	10	Agalinis purpurea	Nt A-FORB	Purple False Foxglove
AGASKI	7	Agalinis skinneriana	Nt A-FORB	Pale False Foxglove
AGATEN	4	Agalinis tenuifolia	Nt A-FORB	Slender False Foxglove
AGAVIR	10	Agalinis viridis	Nt A-FORB	Green False Foxglove
AGANEP	4	Agastache nepetoides	Nt P-FORB	Yellow Giant Hyssop
AGASCR	9	Agastache scrophulariifolia	Nt P-FORB	Purple Giant Hyssop
AGEALT	2	Ageratina altissima	Nt P-FORB	White Snakeroot
AGECON	*	AGERATUM CONYZOIDES	Ad A-FORB	Ageratum
AGRGRY	9	Agrimonia gryposepala	Nt P-FORB	Tall Agrimony
AGRPAR	5	Agrimonia parviflora	Nt P-FORB	Swamp Agrimony
AGRPUB	4	Agrimonia pubescens	Nt P-FORB	Soft Agrimony
AGRROS	4	Agrimonia rostellata	Nt P-FORB	Beaked Agrimony
AGRCRI	*	AGROPYRON CRISTATUM	Ad P-GRASS	Crested Wheat Grass
AGRGIT	*	AGROSTEMMA GITHAGO	Ad A-FORB	Corn Cockle
AGRCAP	*	AGROSTIS CAPILLARIS	Ad P-GRASS	Rhode Island Bent
AGRELL	3	Agrostis elliottiana	Nt A-GRASS	Awned Bent Grass
AGRGIG	*	AGROSTIS GIGANTEA	Ad P-GRASS	Redtop
AGRHYE	3	Agrostis hyemalis	Nt P-GRASS	Tickle Grass
AGRPEA†	8	Agrostis perennans var. aestivalis◀	Nt P-GRASS	Lowland Bent Grass
AGRPEP†	3	Agrostis perennans var. perennans◀	Nt P-GRASS	Upland Bent Grass
AGRSTO	*	AGROSTIS STOLONIFERA◀	Ad P-GRASS	Creeping Bent Grass
AILALT	*	AILANTHUS ALTISSIMA	Ad TREE	Tree Of Heaven
AIRCAR	*	AIRA CARYOPHYLLEA	Ad A-GRASS	Silver Hair Grass
AIRELE	*	AIRA ELEGANS	Ad A-GRASS	Hair Grass
AJUREP	*	AJUGA REPTANS	Ad P-FORB	Common Bugle
AKEQUI	*	AKEBIA QUINATA	Ad W-VINE	Chocolate Vine
ALBJUL	*	ALBIZIA JULIBRISSIN	Ad TREE	Mimosa
ALCROS	*	ALCEA ROSEA	Ad P-FORB	Hollyhock
ALIGRA	8	Alisma gramineum	Nt P-FORB	Grass-Leaved Water Plantain

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ALISUB	3	Alisma subcordatum	Nt P-FORB	Common Water Plantain
ALITRI	5	Alisma triviale	Nt P-FORB	Large-Flowered Water Plantain
ALLPET	*	ALLIARIA PETIOLATA	Ad B-FORB	Garlic Mustard
ALLBUR	9	Allium burdickii	Nt P-FORB	Ramps
ALLCAN	2	Allium canadense◂	Nt P-FORB	Wild Garlic
ALLCEP	*	ALLIUM CEPA	Ad P-FORB	Wild Onion
ALLCER	8	Allium cernuum	Nt P-FORB	Nodding Wild Onion
ALLMUT	7	Allium mutabile◂	Nt P-FORB	Glade Onion
ALLSAT	*	ALLIUM SATIVUM	Ad P-FORB	Garlic
ALLSTE	6	Allium stellatum	Nt P-FORB	Prairie Onion
ALLTRI	8	Allium tricoccum	Nt P-FORB	Wild Leek
ALLTUB	*	ALLIUM TUBEROSUM	Ad P-FORB	Chinese Chives
ALLVIN	*	ALLIUM VINEALE	Ad P-FORB	Field Garlic
ALNGLU	*	ALNUS GLUTINOSA	Ad TREE	European Alder
ALNSER	7	Alnus serrulata	Nt SHRUB	Smooth Alder
ALOAEQ	9	Alopecurus aequalis	Nt P-GRASS	Tufted Foxtail
ALOCAR	0	Alopecurus carolinianus	Nt A-GRASS	Annual Foxtail
ALOPRA	*	ALOPECURUS PRATENSIS	Ad P-GRASS	Meadow Foxtail
ALYALY	*	ALYSSUM ALYSSOIDES	Ad A-FORB	Pale Alyssum
ALYDES	*	ALYSSUM DESERTORUM	Ad A-FORB	Alyssum
AMAALB	0	Amaranthus albus	Nt A-FORB	Tumbleweed
AMAARE	*	AMARANTHUS ARENICOLA	Ad A-FORB	Torrey's Amaranth
AMABLS†	*	AMARANTHUS BLITOIDES◂	Ad A-FORB	Creeping Amaranth
AMABLM†	*	AMARANTHUS BLITUM var. EMARGINATUS	Ad A-FORB	Salad Amaranth
AMACAU	*	AMARANTHUS CAUDATUS	Ad A-FORB	Purple Amaranth
AMACRU	*	AMARANTHUS CRUENTUS	Ad A-FORB	Red Amaranth
AMAHYB	0	Amaranthus hybridus	Nt A-FORB	Green Amaranth
AMAHYP	*	AMARANTHUS HYPOCHONDRIACUS	Ad A-FORB	Prince's Feather
AMAPAL	*	AMARANTHUS PALMERI	Ad A-FORB	Careless Weed
AMAPOW	*	AMARANTHUS POWELLII	Ad A-FORB	Tall Amaranth
AMARET	*	AMARANTHUS RETROFLEXUS◂	Ad A-FORB	Rough Amaranth
AMASPI	*	AMARANTHUS SPINOSUS	Ad A-FORB	Thorny Amaranth
AMATRI	*	AMARANTHUS TRICOLOR	Ad A-FORB	Chinese Spinach
AMATUB	0	Amaranthus tuberculatus	Nt A-FORB	Tall Water Hemp
AMAVIR	*	AMARANTHUS VIRIDIS	Ad A-FORB	Slender Amaranth
AMBACA	*	AMBROSIA ACANTHICARPA	Ad A-FORB	Annual Bursage
AMBART	0	Ambrosia artemisiifolia	Nt A-FORB	Common Ragweed
AMBBID	0	Ambrosia bidentata	Nt A-FORB	Southern Ragweed

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
AMBPSI	3	Ambrosia psilostachya	Nt P-FORB	Western Ragweed
AMBTOM	*	AMBROSIA TOMENTOSA	Ad P-FORB	False Ragweed
AMBTRI	0	Ambrosia trifida	Nt A-FORB	Giant Ragweed
AMEARB	6	Amelanchier arborea	Nt TREE	Shadbush
AMEHUM	*	AMELANCHIER HUMILIS	Ad SHRUB	Low Shadbush
AMIMUS	10	Amianthium muscitoxicum	Nt P-FORB	Fly Poison
AMMCOC	6	Ammannia coccinea	Nt A-FORB	Common Toothcup
AMMROB	8	Ammannia robusta	Nt A-FORB	Grand Toothcup
AMMMAJ	*	AMMI MAJUS	Ad A-FORB	Bishop's Weed
AMMBUT	*	AMMOSELINUM BUTLERI	Ad A-FORB	Sand Parsley
AMOCAN	8	Amorpha canescens	Nt SHRUB	Lead Plant
AMOFRU	6	Amorpha fruticosa	Nt SHRUB	Indigo Bush
AMONIT	8	Amorpha nitens	Nt SHRUB	Shining Indigo Bush
AMPARB	7	Ampelopsis arborea	Nt W-VINE	Pepper Vine
AMPBRE	*	AMPELOPSIS BREVIPEDUNCULATA	Ad W-VINE	Porcelain Berry
AMPCOR	3	Ampelopsis cordata	Nt W-VINE	Raccoon Grape
AMPDRA	3	Amphiachyris dracunculoides	Nt A-FORB	Broom Snakeroot
AMPBRA	4	Amphicarpaea bracteata	Nt A-FORB	Hog Peanut
AMSLYC	*	AMSINCKIA LYCOPSOIDES	Ad A-FORB	Fiddleneck
AMSMEN	*	AMSINCKIA MENZIESII	Ad A-FORB	Menzies Fiddleneck
AMSTES	*	AMSINCKIA TESSELLATA	Ad A-FORB	Devil's Lettuce
AMSCIL	10	Amsonia ciliata var. filifolia	Nt P-FORB	Ciliate Blue Star
AMSILL	7	Amsonia illustris	Nt P-FORB	Shining Blue Star
AMSTAS†	6	Amsonia tabernaemontana var. salicifolia	Nt P-FORB	Blue Star
AMSTAT†	6	Amsonia tabernaemontana var. tabernaemontana	Nt P-FORB	Blue Star
ANAARV	*	ANAGALLIS ARVENSIS	Ad A-FORB	Scarlet Pimpernel
ANAMIN	5	Anagallis minima	Nt A-FORB	Chaffweed
ANAMAR	*	ANAPHALIS MARGARITACEA	Ad P-FORB	Pearly Everlasting
ANCAZU	*	ANCHUSA AZUREA	Ad P-FORB	Showy Bugloss
ANCOFF	*	ANCHUSA OFFICINALIS	Ad P-FORB	Common Bugloss
ANDPHY	9	Andrachne phyllanthoides	Nt SHRUB	Glade Buckbrush
ANDGER	5	Andropogon gerardii	Nt P-GRASS	Big Bluestem
ANDGYR	3	Andropogon gyrans	Nt P-GRASS	Elliott's Broom Sedge
ANDTER	5	Andropogon ternarius	Nt P-GRASS	Splitbeard Bluestem
ANDVIR	2	Andropogon virginicus	Nt P-GRASS	Broom Sedge
ANDOCC	3	Androsace occidentalis	Nt A-FORB	Rock Jasmine
ANEACU	7	Anemone acutiloba◂	Nt P-FORB	Sharp-Lobed Hepatica
ANEAME	6	Anemone americana◂	Nt P-FORB	Round-Lobed Hepatica
ANECAN	6	Anemone canadensis	Nt P-FORB	Meadow Anemone

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ANECAR	7	Anemone caroliniana	Nt P-FORB	Carolina Anemone
ANECYL	9	Anemone cylindrica	Nt P-FORB	Thimbleweed
ANEQUI	10	Anemone quinquefolia	Nt P-FORB	Wood Anemone
ANEVIR	4	Anemone virginiana	Nt P-FORB	Tall Anemone
ANEGRA	*	ANETHUM GRAVEOLENS	Ad A-FORB	Dill
ANGVEN	8	Angelica venenosa	Nt P-FORB	Wood Angelica
ANOCRI	*	ANODA CRISTATA	Ad A-FORB	Crested Velvetleaf
ANTNEG	4	Antennaria neglecta	Nt P-FORB	Field Cat's Foot
ANTPAR	5	Antennaria parlinii	Nt P-FORB	Pussy's Toes
ANTARV	*	ANTHEMIS ARVENSIS	Ad A-FORB	Corn Chamomile
ANTCOT	*	ANTHEMIS COTULA	Ad A-FORB	Dog Fennel
ANTODO	*	ANTHOXANTHUM ODORATUM	Ad P-GRASS	Sweet Vernal Grass
ANTCAU	*	ANTHRISCUS CAUCALIS	Ad A-FORB	Chervil
ANTMAJ	*	ANTIRRHINUM MAJUS	Ad P-FORB	Snapdragon
APEINT	*	APERA INTERRUPTA	Ad A-GRASS	Italian Wind Grass
APESPI	*	APERA SPICA-VENTI	Ad A-GRASS	Loose Silky Bent
APHAUS	*	APHANES AUSTRALIS	Ad A-FORB	Parsley Piert
APHSKI	*	APHANOSTEPHUS SKIRRHOBASIS	Ad A-FORB	Arkansas Lazydaisy
APIAME	6	Apios americana	Nt P-FORB	Groundnut
APIGRA	*	APIUM GRAVEOLENS	Ad P-FORB	Celery
APLHYE	8	Aplectrum hyemale	Nt P-FORB	Putty Root Orchid
APOFLO	4	Apocynum × floribundum ◄	Nt P-FORB	Intermediate Dogbane
APOAND	5	Apocynum androsaemifolium	Nt P-FORB	Spreading Dogbane
APOCAN	3	Apocynum cannabinum ◄	Nt P-FORB	Prairie Dogbane
APOSIB	3	Apocynum sibiricum ◄	Nt P-FORB	Indian Hemp
AQUCAN	6	Aquilegia canadensis	Nt P-FORB	Columbine
ARALYR	8	Arabidopsis lyrata	Nt B-FORB	Sand Cress
ARATHA	*	ARABIDOPSIS THALIANA	Ad A-FORB	Mouse-Ear Cress
ARAHIR	6	Arabis hirsuta	Nt B-FORB	Hairy Rock Cress
ARAHYP	*	ARACHIS HYPOGAEA	Ad P-FORB	Peanut
ARAELA	*	ARALIA ELATA	Ad TREE	Japanese Angelica Tree
ARANUD	10	Aralia nudicaulis	Nt P-FORB	Wild Sarsaparilla
ARARAC	8	Aralia racemosa	Nt P-FORB	Spikenard
ARASPI	6	Aralia spinosa	Nt SHRUB	Hercule's Club
ARCMIN	*	ARCTIUM MINUS	Ad B-FORB	Common Burdock
ARESER	*	ARENARIA SERPYLLIFOLIA	Ad A-FORB	Thyme-Leaved Sandwort
ARGALB	*	ARGEMONE ALBIFLORA	Ad A-FORB	Prickly Poppy
ARGMEX	*	ARGEMONE MEXICANA	Ad A-FORB	Mexican Poppy
ARGDEA	9	Argyrochosma dealbata	Nt FERN	Cloak Fern

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ARIDRA	6	Arisaema dracontium	Nt P-FORB	Green Dragon
ARITRI	6	Arisaema triphyllum	Nt P-FORB	Jack-In-The Pulpit
ARIADS	5	Aristida adscensionis	Nt A-GRASS	Sixweeks Three-Awn
ARIBAS	4	Aristida basiramea	Nt A-GRASS	Fork-Tipped Three-Awn Grass
ARIDES	8	Aristida desmantha	Nt A-GRASS	Curly Three-Awn
ARIDIU†	3	Aristida dichotoma var. curtissii	Nt A-GRASS	Churchmouse Three-Awn
ARIDID†	3	Aristida dichotoma var. dichotoma	Nt A-GRASS	Poverty Grass
ARILAN	9	Aristida lanosa	Nt P-GRASS	Woollyleaf Three-Awn
ARILOG†	4	Aristida longespica var. geniculata	Nt A-GRASS	False Arrow Feather
ARILOL†	2	Aristida longespica var. longespica	Nt A-GRASS	Slimspike Three-Awn
ARIOLI	1	Aristida oligantha	Nt A-GRASS	Plains Three-Awn Grass
ARIPUR	5	Aristida purpurascens	Nt P-GRASS	Arrow Feather
ARIRAM	4	Aristida ramosissima	Nt A-GRASS	Slender Three-Awn
ARISEH†	6	Aristolochia serpentaria var. hastata◄	Nt P-FORB	Virginia Snakeroot
ARISES†	6	Aristolochia serpentaria var. serpentaria◄	Nt P-FORB	Virginia Snakeroot
ARITOM	7	Aristolochia tomentosa	Nt W-VINE	Pipe-Vine
ARMRUS	*	ARMORACIA RUSTICANA	Ad P-FORB	Horse Radish
ARNATR	4	Arnoglossum atriplicifolium	Nt P-FORB	Pale Indian Plantain
ARNPLA	8	Arnoglossum plantagineum	Nt P-FORB	Prairie Indian Plantain
ARNREN	8	Arnoglossum reniforme	Nt P-FORB	Great Indian Plantain
AROMEL	10	Aronia melanocarpa	Nt SHRUB	Black Chokeberry
ARRELA	*	ARRHENATHERUM ELATIUS	Ad P-GRASS	Tall Oat Grass
ARTABS	*	ARTEMISIA ABSINTHIUM	Ad P-FORB	Common Wormwood
ARTANN	*	ARTEMISIA ANNUA	Ad A-FORB	Sweet Wormwood
ARTBIE	*	ARTEMISIA BIENNIS	Ad B-FORB	Biennial Wormwood
ARTCAM	5	Artemisia campestris subsp. caudata	Nt B-FORB	Beach Wormwood
ARTCAR	*	ARTEMISIA CARRUTHII	Ad P-FORB	Kansas Mugwort
ARTDRA	8	Artemisia dracunculus	Nt P-FORB	Tarragon
ARTFRI	*	ARTEMISIA FRIGIDA	Ad SHRUB	Prairie Sagebrush
ARTLUL†	3	Artemisia ludoviciana var. ludoviciana	Nt P-FORB	White Sage
ARTLUM†	3	Artemisia ludoviciana var. mexicana	Nt P-FORB	Mexican White Sage
ARTSTE	*	ARTEMISIA STELLARIANA	Ad P-FORB	Dusty Miller
ARTVUL	*	ARTEMISIA VULGARIS	Ad P-FORB	Mugwort
ARTHIS	*	ARTHRAXON HISPIDUS	Ad A-GRASS	Small Carpgrass
ARUITA	*	ARUM ITALICUM	Ad P-FORB	Italian Arum
ARUDIO	6	Aruncus dioicus var. pubescens	Nt P-FORB	Goat's Beard
ARUGIG	7	Arundinaria gigantea	Nt P-GRASS	Cane
ARUDON	*	ARUNDO DONAX	Ad P-GRASS	Giant Reed
ASACAN	6	Asarum canadense	Nt P-FORB	Wild Ginger

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ASCAMP	7	Asclepias amplexicaulis	Nt P-FORB	Sand Milkweed
ASCEXA	10	Asclepias exaltata	Nt P-FORB	Poke Milkweed
ASCHIR	4	Asclepias hirtella	Nt P-FORB	Tall Green Milkweed
ASCINC	4	Asclepias incarnata	Nt P-FORB	Swamp Milkweed
ASCMEA	10	Asclepias meadii	Nt P-FORB	Mead's Milkweed
ASCPER	9	Asclepias perennis	Nt P-FORB	White Milkweed
ASCPUR	6	Asclepias purpurascens	Nt P-FORB	Purple Milkweed
ASCQUA	6	Asclepias quadrifolia	Nt P-FORB	Four-Leaved Milkweed
ASCSPE	*	ASCLEPIAS SPECIOSA◄	Ad P-FORB	Showy Milkweed
ASCSTE	9	Asclepias stenophylla	Nt P-FORB	Glade Milkweed
ASCSUB	*	ASCLEPIAS SUBVERTICILLATA	Ad P-FORB	Poison Milkweed
ASCSUL	8	Asclepias sullivantii	Nt P-FORB	Prairie Milkweed
ASCSYR	0	Asclepias syriaca	Nt P-FORB	Common Milkweed
ASCTUB	5	Asclepias tuberosa subsp. interior	Nt P-FORB	Butterfly Weed
ASCVAR	9	Asclepias variegata	Nt P-FORB	White-Flowered Milkweed
ASCVER	2	Asclepias verticillata	Nt P-FORB	Whorled Milkweed
ASCVIA†	7	Asclepias viridiflora	Nt P-FORB	Short Green Milkweed
ASCVIS†	5	Asclepias viridis	Nt P-FORB	Green-Flowered Milkweed
ASITRI	5	Asimina triloba	Nt TREE	Pawpaw
ASPOFF	*	ASPARAGUS OFFICINALIS	Ad P-FORB	Asparagus
ASPSPR	*	ASPARAGUS SPRENGERI	Ad P-FORB	Asparagus Fern
ASPEBE	10	Asplenium × ebenoides	Nt FERN	Walking Spleenwort
ASPGRA	10	Asplenium × gravesii	Nt FERN	Grave's Spleenwort
ASPBRA	10	Asplenium bradleyi	Nt FERN	Bradley's Spleenwort
ASPMON	10	Asplenium montanum	Nt FERN	Mountain Spleenwort
ASPPIN	10	Asplenium pinnatifidum	Nt FERN	Lobed Spleenwort
ASPPLA	4	Asplenium platyneuron	Nt FERN	Ebony Spleenwort
ASPRES	9	Asplenium resiliens	Nt FERN	Black Spleenwort
ASPRHI	7	Asplenium rhizophyllum	Nt FERN	Walking Fern
ASPRUT	10	Asplenium ruta-muraria	Nt FERN	Wall-Rue Spleenwort
ASPTRI	9	Asplenium trichomanes	Nt FERN	Maidenhair Spleenwort
ASTTAT	*	ASTER TATARICUS	Ad P-FORB	Tatarian Aster
ASTCAN	6	Astragalus canadensis	Nt P-FORB	Canadian Milk Vetch
ASTCRC†	10	Astragalus crassicarpus var. crassicarpus	Nt P-FORB	Indian Pea
ASTCRT†	7	Astragalus crassicarpus var. trichocalyx	Nt P-FORB	Ground Plum
ASTDIS	6	Astragalus distortus	Nt P-FORB	Bent Milk Vetch
ASTLOT	10	Astragalus lotiflorus	Nt P-FORB	Low Milk Vetch
ASTCIL	7	Astranthium ciliatum	Nt A-FORB	Western Daisy
ATHFIL	8	Athyrium filix-femina	Nt FERN	Lady Fern

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ATOARM	*	ATOCION ARMERIA	Ad A-FORB	Sweet William Catchfly
ATRARG	*	ATRIPLEX ARGENTEA	Ad A-FORB	Silver Orach
ATRHOR	*	ATRIPLEX HORTENSIS	Ad A-FORB	Garden Orach
ATRMIC	*	ATRIPLEX MICRANTHA	Ad A-FORB	Russian Orach
ATRPAT	*	ATRIPLEX PATULA	Ad A-FORB	Common Orach
ATRPRO	*	ATRIPLEX PROSTRATA	Ad A-FORB	Arrow-Leaved Orach
ATRROS	*	ATRIPLEX ROSEA	Ad A-FORB	Red Orach
ATRTRU	*	ATRIPLEX TRUNCATA	Ad A-FORB	Silver Scale
ATRWRI	*	ATRIPLEX WRIGHTII	Ad A-FORB	Wright's Saltbush
AUBDEL	*	AUBRIETA DELTOIDEA	Ad P-FORB	Purple Alyssum
AURFLC†	8	Aureolaria flava var. calycosa◄	Nt P-FORB	Smooth False Foxglove
AURFLF†	8	Aureolaria flava var. flava◄	Nt P-FORB	Smooth False Foxglove
AURGRP†	6	Aureolaria grandiflora var. pulchra	Nt P-FORB	Yellow False Foxglove
AURGRS†	6	Aureolaria grandiflora var. serrata	Nt P-FORB	Big-Flowered Gerardia
AURPEC	7	Aureolaria pectinata	Nt A-FORB	Clammy False Foxglove
AVEFAF†	*	AVENA FATUA var. FATUA	Ad A-GRASS	Wild Oats
AVEFAS†	*	AVENA FATUA var. SATIVA	Ad A-GRASS	Oats
AXYAMA	*	AXYRIS AMARANTHOIDES	Ad A-FORB	Russian Pigweed
AZOCAR	8	Azolla caroliniana	Nt FERN	Eastern Water Fern
AZOMEX	8	Azolla mexicana	Nt FERN	Water Fern
BACWRI	*	BACCHARIS WRIGHTII	Ad SHRUB	Wright's False Willow
BACROT	6	Bacopa rotundifolia	Nt P-FORB	Water Hyssop
BAPALB	6	Baptisia alba var. macrophylla	Nt P-FORB	White Wild Indigo
BAPAUS	8	Baptisia australis var. minor	Nt P-FORB	Blue Wild Indigo
BAPBRA	7	Baptisia bracteata var. leucophaea	Nt P-FORB	Cream Wild Indigo
BAPSPH	*	BAPTISIA SPHAEROCARPA◄	Ad P-FORB	Yellow Wild Indigo
BARVER	*	BARBAREA VERNA	Ad B-FORB	Early Wintercress
BARVUL	*	BARBAREA VULGARIS	Ad B-FORB	Yellow Rocket
BARPAN	10	Bartonia paniculata	Nt A-FORB	Screwstem
BARVIR	10	Bartonia virginica	Nt A-FORB	Yellow Screwstem
BELCHI	*	BELAMCANDA CHINENSIS	Ad P-FORB	Blackberry Lily
BERCAN	10	Berberis canadensis	Nt SHRUB	American Barberry
BERTHU	*	BERBERIS THUNBERGII	Ad SHRUB	Japanese Barberry
BERVUL	*	BERBERIS VULGARIS	Ad SHRUB	European Barberry
BERSCA	6	Berchemia scandens	Nt W-VINE	Supple Jack
BERGTE†	7	Bergia texana	Nt A-FORB	Bergia
BERLTE†	5	Berlandiera texana	Nt P-FORB	Green Eyes
BERINC	*	BERTEROA INCANA	Ad A-FORB	Hoary Alyssum
BERERE	10	Berula erecta	Nt P-FORB	Fen Water Parsnip

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
BETVUL	*	BETA VULGARIS	Ad B-FORB	Beta
BETNIG	4	Betula nigra	Nt TREE	River Birch
BIDALB	*	BIDENS ALBA var. RADIATA	Ad A-FORB	Romerillo
BIDARI	1	Bidens aristosa◀	Nt A-FORB	Swamp Marigold
BIDBEC	10	Bidens beckii	Nt P-FORB	Water Marigold
BIDBIP	*	BIDENS BIPINNATA	Ad A-FORB	Spanish Needles
BIDCER	5	Bidens cernua	Nt A-FORB	Nodding Bur Marigold
BIDCOM	3	Bidens comosa◀	Nt A-FORB	Swamp Tickseed
BIDCON	3	Bidens connata◀	Nt A-FORB	Purple-Stemmed Tickseed
BIDDIS	8	Bidens discoidea	Nt A-FORB	Swamp Beggar's Ticks
BIDFRO	2	Bidens frondosa	Nt A-FORB	Common Beggar's Ticks
BIDLAE	10	Bidens laevis	Nt A-FORB	Smooth Beggar's Ticks
BIDPOL	1	Bidens polylepis◀	Nt A-FORB	Bur Marigold
BIDTRI	*	BIDENS TRICHOSPERMA	Ad A-FORB	Tall Swamp Marigold
BIDVUL	1	Bidens vulgata	Nt A-FORB	Tall Beggar's Ticks
BIGCAP	6	Bignonia capreolata	Nt W-VINE	Cross-Vine
BLECIL	6	Blephilia ciliata	Nt P-FORB	Ohio Horse Mint
BLEHIR	7	Blephilia hirsuta	Nt P-FORB	Wood Mint
BOECAN	4	Boechera canadensis	Nt B-FORB	Sickle Pod
BOELAE	6	Boechera laevigata	Nt B-FORB	Smooth Bank Cress
BOEMIS	5	Boechera missouriensis	Nt B-FORB	Missouri Rock Cress
BOESHO	6	Boechera shortii	Nt B-FORB	Toothed Cress
BOECYL	4	Boehmeria cylindrica	Nt P-FORB	False Nettle
BOEERE	*	BOERHAAVIA ERECTA	Ad A-FORB	Spiderling
BOLFLU	6	Bolboschoenus fluviatilis	Nt P-SEDGE	River Bulrush
BOLMAR	10	Bolboschoenus maritimus subsp. paludosus	Nt P-SEDGE	Alkali Bulrush
BOLAST	4	Boltonia asteroides	Nt P-FORB	False Aster
BOLDEC	8	Boltonia decurrens	Nt P-FORB	Decurrent False Aster
BOLDIF	7	Boltonia diffusa	Nt P-FORB	Doll's Daisy
BOTBLA	*	BOTHRIOCHLOA BLADHII	Ad P-GRASS	Caucasian Bluestem
BOTISC	*	BOTHRIOCHLOA ISCHAEMUM	Ad P-GRASS	Yellow Bluestem
BOTLAG	0	Bothriochloa laguroides subsp. torreyana	Nt P-GRASS	Silver Beard Grass
BOTBIT	10	Botrychium biternatum	Nt FERN	Grape Fern
BOTDIS	5	Botrychium dissectum	Nt FERN	Cut-Leaved Grape Fern
BOTVIR	4	Botrychium virginianum	Nt FERN	Rattlesnake Fern
BOUCUR	7	Bouteloua curtipendula	Nt P-GRASS	Side-Oats Grama
BOUGRA	8	Bouteloua gracilis	Nt P-GRASS	Blue Grama
BOUHIR	10	Bouteloua hirsuta	Nt P-GRASS	Hairy Grama
BRAERU	*	BRACHIARIA ERUCIFORMIS	Ad A-GRASS	Signal Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
BRAERE	5	Brachyelytrum erectum	Nt P-GRASS	Long-Awned Wood Grass
BRAPIL	3	Bradburia pilosa	Nt A-FORB	Soft-Golden Aster
BRASCH	2	Brasenia schreberi	Nt P-FORB	Water Shield
BRAJUN	*	BRASSICA JUNCEA	Ad A-FORB	Indian Mustard
BRANAP	*	BRASSICA NAPUS	Ad A-FORB	Turnip
BRANIG	*	BRASSICA NIGRA	Ad A-FORB	Black Mustard
BRARAP	*	BRASSICA RAPA	Ad A-FORB	Field Mustard
BRIEUE†	6	Brickellia eupatorioides var. eupatorioides	Nt P-FORB	False Boneset
BRIEUT†	7	Brickellia eupatorioides var. texana	Nt P-FORB	Ozark False Boneset
BRIGRA	10	Brickellia grandiflora	Nt P-FORB	Tassel Flower
BROCOM	*	BROMUS COMMUTATUS	Ad A-GRASS	Hairy Chess
BRODIA	*	BROMUS DIANDRUS	Ad A-GRASS	Ribgut Grass
BROHOR	*	BROMUS HORDACEUS	Ad A-GRASS	Soft Chess
BROINE	*	BROMUS INERMIS	Ad P-GRASS	Smooth Brome
BROJAP	*	BROMUS JAPONICUS	Ad A-GRASS	Japanese Chess
BROLAT	7	Bromus latiglumis	Nt P-GRASS	Ear-Leaved Brome
BRONOT	8	Bromus nottowayanus	Nt P-GRASS	Nottoway Brome
BROPUB	5	Bromus pubescens	Nt P-GRASS	Woodland Brome
BRORAC	*	BROMUS RACEMOSUS	Ad A-GRASS	Smooth Chess
BROSEC	*	BROMUS SECALINUS	Ad A-GRASS	Chess
BROSQU	*	BROMUS SQUARROSUS	Ad P-GRASS	Nodding Brome
BROSTE	*	BROMUS STERILIS	Ad A-GRASS	Poverty Brome
BROTEC	*	BROMUS TECTORUM	Ad A-GRASS	Downy Brome
BROWIL	*	BROMUS WILLDENOWII	Ad A-GRASS	Rescue Grass
BROPAP	*	BROUSSONETIA PAPYRIFERA	Ad TREE	Paper Mulberry
BRUMAC	*	BRUNNERA MACROPHYLLA	Ad P-FORB	Siberian Bugloss
BRUOVA	4	Brunnichia ovata	Nt W-VINE	Ladies' Eardrops
BUCDAC	5	Buchloe dactyloides	Nt P-GRASS	Buffalo Grass
BUCAME	10	Buchnera americana	Nt P-FORB	Blue Hearts
BUDDAV	*	BUDDLEJA DAVIDII	Ad SHRUB	Butterfly Bush
BUGARV	*	BUGLOSSOIDES ARVENSE	Ad A-FORB	Corn Gromwell
BULCAP	4	Bulbostylis capillaris	Nt A-SEDGE	Hair Sedge
BUPROT	*	BUPLEURUM ROTUNDIFOLIUM	Ad A-FORB	Hare's Ear
CABCAR	8	Cabomba caroliniana	Nt P-FORB	Fanwort
CALCAN	6	Calamagrostis canadensis	Nt P-GRASS	Blue Joint Grass
CALPOR	10	Calamagrostis porteri subsp. insperata	Nt P-GRASS	Reed Bent Grass
CALSTR	8	Calamagrostis stricta subsp. inexpansa	Nt P-GRASS	Bog Reed Grass
CALLON	*	CALAMOVILFA LONGIFOLIA◂	Ad P-GRASS	Sand Reed
CALAME	10	Callicarpa americana	Nt SHRUB	American Beauty Berry

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CALDIC	*	CALLICARPA DICHOTOMA	Ad SHRUB	Chinese Beauty Berry
CALALC	6	Callirhoe alcaeoides	Nt P-FORB	Pink Poppy Mallow
CALBUS	9	Callirhoe bushii	Nt P-FORB	Bush's Poppy Mallow
CALDIG	8	Callirhoe digitata	Nt P-FORB	Fringed Poppy Mallow
CALINV	5	Callirhoe involucrata	Nt P-FORB	Purple Poppy Mallow
CALTRI	10	Callirhoe triangulata	Nt P-FORB	Clustered Poppy Mallow
CALHET	6	Callitriche heterophylla	Nt A-FORB	Large Water Starwort
CALLPA†	9	Callitriche palustris	Nt A-FORB	Common Water Starwort
CALTER	3	Callitriche terrestris	Nt A-FORB	Terrestrial Starwort
CALOKL	10	Calopogon oklahomensis	Nt P-FORB	Prairie Grass Pink
CALTUB	10	Calopogon tuberosus	Nt P-FORB	Grass Pink
CALTPA†	10	Caltha palustris	Nt P-FORB	Marsh Marigold
CALFLO	*	CALYCANTHUS FLORIDUS	Ad SHRUB	Carolina Allspice
CALLYO	7	Calycocarpum lyonii	Nt W-VINE	Cupseed
CALSER	4	Calylophus serrulatus	Nt P-FORB	Toothed Evening Primrose
CALMAC	5	Calystegia macounii	Nt P-FORB	Macoun's Bindweed
CALPUB	*	CALYSTEGIA PUBESCENS	Ad P-FORB	Japanese Bindweed
CALSEP	1	Calystegia sepium	Nt P-FORB	Hedge Bindweed
CALSIL	1	Calystegia silvatica subsp. fraterniflora	Nt P-FORB	Shortstalk Bindweed
CALSPI	9	Calystegia spithamaea	Nt P-FORB	Low Bindweed
CAMANG	10	Camassia angusta	Nt P-FORB	Prairie Hyacinth
CAMSCI	6	Camassia scilloides	Nt P-FORB	Wild Hyacinth
CAMMIC	*	CAMELINA MICROCARPA	Ad A-FORB	Small-Fruited False Flax
CAMSAT	*	CAMELINA SATIVA	Ad A-FORB	False Flax
CAMAME	4	Campanula americana	Nt A-FORB	Tall Bellflower
CAMAPA	10	Campanula aparinoides	Nt P-FORB	Marsh Bellflower
CAMRAP	*	CAMPANULA RAPUNCULOIDES	Ad P-FORB	European Bellflower
CAMROT	10	Campanula rotundifolia	Nt P-FORB	Harebell
CAMRAD	3	Campsis radicans	Nt W-VINE	Trumpet Creeper
CANENS	*	CANAVALIA ENSIFORMIS	Ad A-FORB	Jack Bean
CANSAT	*	CANNABIS SATIVA	Ad A-FORB	Hemp
CAPBUR	*	CAPSELLA BURSA-PASTORIS	Ad A-FORB	Shepherd's Purse
CAPANN	*	CAPSICUM ANNUUM	Ad A-FORB	Cayenne Pepper
CARBUL	7	Cardamine bulbosa	Nt P-FORB	Bulbous Cress
CARCON	4	Cardamine concatenata	Nt P-FORB	Toothwort
CARDIP	10	Cardamine diphylla	Nt P-FORB	Crinkleroot
CARDOU	9	Cardamine douglasii	Nt P-FORB	Purple Spring Cress
CARFLE	*	CARDAMINE FLEXUOSA	Ad B-FORB	Woodland Bitter Cress
CARHIR	*	CARDAMINE HIRSUTA	Ad A-FORB	Hairy Bitter Cress

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CARPAR	3	Cardamine parviflora var. arenicola	Nt A-FORB	Small-Flowered Bitter Cress
CARPEN	6	Cardamine pensylvanica	Nt B-FORB	Pennsylvania Bitter Cress
CARHAL	*	CARDIOSPERMUM HALICACABUM	Ad A-FORB	Balloon Vine
CARCRI	*	CARDUUS CRISPUS	Ad B-FORB	Welted Thistle
CARNUT	*	CARDUUS NUTANS	Ad B-FORB	Musk Thistle
CXDEAM†	8	Carex × deamii	Nt P-SEDGE	Deam's Sedge
CXSUBI†	10	Carex × subimpressa	Nt P-SEDGE	Impressed Sedge
CXABSC†	10	Carex abscondita	Nt P-SEDGE	Thicket Sedge
CXAGGR†	4	Carex aggregata	Nt P-SEDGE	Glomerate Sedge
CXALAT†	9	Carex alata	Nt P-SEDGE	Winged Sedge
CXALBB†	6	Carex albicans var. albicans	Nt P-SEDGE	Bellows-Beaked Sedge
CXALBS†	6	Carex albicans var. australis	Nt P-SEDGE	White-Tinged Sedge
CXALBO†	9	Carex albolutescens	Nt P-SEDGE	Greenish-White Sedge
CXALBU†	9	Carex albursina	Nt P-SEDGE	White Bear Sedge
CXAMPH†	3	Carex amphibola	Nt P-SEDGE	Narrow-Leaved Sedge
CXANNA†	4	Carex annectens var. annectens	Nt P-SEDGE	Yellow-Fruited Sedge
CXANNX†	4	Carex annectens var. xanthocarpa	Nt P-SEDGE	Yellow-Fruited Sedge
CXAQUA†	10	Carex aquatilis	Nt P-SEDGE	Water Sedge
CXARKA†	8	Carex arkansana	Nt P-SEDGE	Arkansas Sedge
CXATHE†	10	Carex atherodes	Nt P-SEDGE	Slough Sedge
CXATLA†	10	Carex atlantica	Nt P-SEDGE	Prickly Bog Sedge
CXAURE†	5	Carex aureolensis◀	Nt P-SEDGE	Splendid Sedge
CXAUST†	5	Carex austrina	Nt P-SEDGE	Southern Sedge
CXBICK†	8	Carex bicknellii	Nt P-SEDGE	Bicknell's Sedge
CXBLAN†	2	Carex blanda	Nt P-SEDGE	Common Wood Sedge
CXBREV†	4	Carex brevior	Nt P-SEDGE	Short-Beaked Sedge
CXBROM†	10	Carex bromoides	Nt P-SEDGE	Brome-Like Sedge
CXBUSH†	4	Carex bushii	Nt P-SEDGE	Bush's Sedge
CXBUXB†	10	Carex buxbaumii	Nt P-SEDGE	Brown Bog Sedge
CXCARY†	9	Carex careyana	Nt P-SEDGE	Carey's Sedge
CXCARO†	7	Carex caroliniana	Nt P-SEDGE	Carolina Sedge
CXCEPH†	5	Carex cephalophora	Nt P-SEDGE	Woodbank Sedge
CXCHER†	7	Carex cherokeensis	Nt P-SEDGE	Cherokee Sedge
CXCOMM†	10	Carex communis	Nt P-SEDGE	Fibrous-Rooted Sedge
CXCOMO†	9	Carex comosa	Nt P-SEDGE	Bristly Sedge
CXCOMP†	9	Carex complanata	Nt P-SEDGE	Hirsute Sedge
CXCONJ†	5	Carex conjuncta	Nt P-SEDGE	Soft Fox Sedge
CXCONO†	10	Carex conoidea	Nt P-SEDGE	Field Sedge
CXCORR†	8	Carex corrugata	Nt P-SEDGE	Prune-Fruit Sedge

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CXCRAE†	10	Carex crawei	Nt P-SEDGE	Crawe's Sedge
CXCRAF†	*	CAREX CRAWFORDII	Ad P-SEDGE	Crawford's Sedge
CXCRIN†	7	Carex crinita	Nt P-SEDGE	Fringed Sedge
CXCRIS†	4	Carex cristatella	Nt P-SEDGE	Crested Sedge
CXCRUS†	6	Carex crus-corvi	Nt P-SEDGE	Raven's Foot Sedge
CXCUMB†	10	Carex cumberlandensis◄	Nt P-SEDGE	Cumberland Sedge
CXDAVI†	3	Carex davisii	Nt P-SEDGE	Davis' Sedge
CXDEBI†	10	Carex debilis	Nt P-SEDGE	White-Edged Sedge
CXDECO†	10	Carex decomposita	Nt P-SEDGE	Epiphytic Sedge
CXDIGI†	7	Carex digitalis	Nt P-SEDGE	Narrow-Leaved Wood Sedge
CXDOUG†	*	CAREX DOUGLASII	Ad P-SEDGE	Douglas' Sedge
CXEBUR†	7	Carex eburnea	Nt P-SEDGE	Bristle-Leaved Sedge
CXELEO†	*	CAREX ELEOCHARIS	Ad P-SEDGE	Needleleaf Sedge
CXEMOR†	6	Carex emoryi	Nt P-SEDGE	Emory's Sedge
CXFEST†	5	Carex festucacea	Nt P-SEDGE	Fescue Sedge
CXFISS†	6	Carex fissa	Nt P-SEDGE	Swale Sedge
CXFLAC†	8	Carex flaccosperma	Nt P-SEDGE	Thin-Fruited Sedge
CXFRAN†	2	Carex frankii◄	Nt P-SEDGE	Frank's Sedge
CXGIGA†	9	Carex gigantea	Nt P-SEDGE	Large Sedge
CXGLAU†	4	Carex glaucodea	Nt P-SEDGE	Blue Sedge
CXGRAS†	7	Carex gracilescens	Nt P-SEDGE	Slender Wood Sedge
CXGRAA†	10	Carex gracillima	Nt P-SEDGE	Graceful Sedge
CXGRAN†	4	Carex granularis	Nt P-SEDGE	Meadow Sedge
CXGRAV†	5	Carex gravida	Nt P-SEDGE	Heavy Sedge
CXGRAY†	7	Carex grayii	Nt P-SEDGE	Bur Sedge
CXGRIS†	4	Carex grisea	Nt P-SEDGE	Gray Sedge
CXHAYD†	9	Carex haydenii	Nt P-SEDGE	Cloud Sedge
CXHIRS†	4	Carex hirsutella	Nt P-SEDGE	Fuzzy Wuzzy Sedge
CXHIRT†	7	Carex hirtifolia	Nt P-SEDGE	Hairy Sedge
CXHITC†	9	Carex hitchcockiana	Nt P-SEDGE	Hitchcock's Sedge
CXHYAL†	6	Carex hyalinolepis	Nt P-SEDGE	Shoreline Sedge
CXHYST†	7	Carex hystericina	Nt P-SEDGE	Bottlebrush Sedge
CXINOP†	6	Carex inops subsp. heliophila	Nt P-SEDGE	Sun Sedge
CXINTE†	10	Carex interior	Nt P-SEDGE	Interior Sedge
CXINTU†	7	Carex intumescens	Nt P-SEDGE	Swollen Sedge
CXJAME†	4	Carex jamesii	Nt P-SEDGE	Grass Sedge
CXJOOR†	10	Carex joorii	Nt P-SEDGE	Cypress Swamp Sedge
CXLACU†	10	Carex lacustris	Nt P-SEDGE	Lake Bank Sedge
CXLAEC†	9	Carex laeviconica	Nt P-SEDGE	Smooth Cone Sedge

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CXLAEV†	10	Carex laevivaginata	Nt P-SEDGE	Smooth-Sheath Sedge
CXLAXC†	10	Carex laxiculmis var. copulata◄	Nt P-SEDGE	Spreading Sedge
CXLAXL†	10	Carex laxiculmis var. laxiculmis◄	Nt P-SEDGE	Spreading Sedge
CXLAXF†	10	Carex laxiflora	Nt P-SEDGE	Beechwood Sedge
CXLEAV†	3	Carex leavenworthii	Nt P-SEDGE	Leavenworth's Sedge
CXLEPT†	10	Carex leptalea	Nt P-SEDGE	Bristle-Stalked Sedge
CXLONG†	10	Carex longii	Nt P-SEDGE	Long's Sedge
CXLOUI†	8	Carex louisianica	Nt P-SEDGE	Louisiana Sedge
CXLUPF†	9	Carex lupuliformis	Nt P-SEDGE	Knobbed Hop Sedge
CXLUPL†	6	Carex lupulina	Nt P-SEDGE	Common Hop Sedge
CXLURI†	6	Carex lurida	Nt P-SEDGE	Sallow Sedge
CXMEAD†	6	Carex meadii	Nt P-SEDGE	Mead's Sedge
CXMESO†	3	Carex mesochorea	Nt P-SEDGE	Oval-Headed Sedge
CXMICR†	10	Carex microdonta	Nt P-SEDGE	Little Tooth Sedge
CXMISS†	8	Carex missouriensis◄	Nt P-SEDGE	Missouri Sedge
CXMOLA†	3	Carex molesta	Nt P-SEDGE	Troublesome Sedge
CXMOLI†	4	Carex molestiformis	Nt P-SEDGE	Frightful Sedge
CXMUHE†	8	Carex muehlenbergii var. enervis	Nt P-SEDGE	Sand Sedge
CXMUHM†	5	Carex muehlenbergii var. muehlenbergii	Nt P-SEDGE	Sand Sedge
CXMUSK†	9	Carex muskingumensis	Nt P-SEDGE	Swamp Sedge
CXNEBR†	*	CAREX NEBRASCENSIS	Ad P-SEDGE	Nebraska Sedge
CXNIGF†	7	Carex nigromarginata var. floridana	Nt P-SEDGE	Black-Edged Sedge
CXNIGN†	7	Carex nigromarginata var. nigromarginata	Nt P-SEDGE	Black-Edged Sedge
CXNORM†	4	Carex normalis	Nt P-SEDGE	Larger Straw Sedge
CXOKLA†	8	Carex oklahomensis	Nt P-SEDGE	Oklahoma Sedge
CXOLIG†	6	Carex oligocarpa	Nt P-SEDGE	Few-Fruited Sedge
CXOPAC†	9	Carex opaca	Nt P-SEDGE	Prairie Sedge
CXOXYL†	10	Carex oxylepis	Nt P-SEDGE	Sharp-Scaled Sedge
CXPELL†	5	Carex pellita	Nt P-SEDGE	Woolly Sedge
CXPENS†	6	Carex pensylvanica	Nt P-SEDGE	Pennsylvania Sedge
CXPLAN†	8	Carex planispicata	Nt P-SEDGE	Flat-Spiked Sedge
CXPRAE†	*	CAREX PRAEGRACILIS	Ad P-SEDGE	Tollway Sedge
CXPRAS†	8	Carex prasina	Nt P-SEDGE	Leek Sedge
CXRADI†	5	Carex radiata	Nt P-SEDGE	Eastern Star Sedge
CXRENE†	10	Carex reniformis	Nt P-SEDGE	Kidney-Fruited Sedge
CXRETR†	4	Carex retroflexa	Nt P-SEDGE	Reflexed Sedge
CXREZN†	10	Carex reznicekii◄	Nt P-SEDGE	Tony's Sedge
CXROSE†	6	Carex rosea	Nt P-SEDGE	Stellate Sedge
CXSART†	10	Carex sartwellii	Nt P-SEDGE	Sartwell's Sedge

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CXSCAB†	10	Carex scabrata	Nt P-SEDGE	Rough Sedge
CXSCHW†	10	Carex schweinitzii	Nt P-SEDGE	Schweinitz's Sedge
CXSCOP†	5	Carex scoparia	Nt P-SEDGE	Pointed Broom Sedge
CXSHOR†	4	Carex shortiana	Nt P-SEDGE	Short's Sedge
CXSOCI†	10	Carex socialis	Nt P-SEDGE	Cespitose Sedge
CXSPAR†	5	Carex sparganioides	Nt P-SEDGE	Bur-Reed Sedge
CXSPRE†	10	Carex sprengelii	Nt P-SEDGE	Long-Beaked Sdge
CXSQUA†	6	Carex squarrosa	Nt P-SEDGE	Squarrose Sedge
CXSTER†	10	Carex sterilis	Nt P-SEDGE	Dioecious Sedge
CXSTIP†	4	Carex stipata	Nt P-SEDGE	Sawbeak Sedge
CXSTRA†	10	Carex straminea	Nt P-SEDGE	Straw Sedge
CXSTRI†	10	Carex stricta	Nt P-SEDGE	Tussock Sedge
CXSUBE†	9	Carex suberecta	Nt P-SEDGE	Prairie Straw Sedge
CXSWAN†	7	Carex swanii	Nt P-SEDGE	Savanna Sedge
CXSYCN†	10	Carex sychnocephala	Nt P-SEDGE	Many-Headed Sedge
CXTENE†	10	Carex tenera	Nt P-SEDGE	Slender Sedge
CXTETA†	10	Carex tetanica	Nt P-SEDGE	Rigid Sedge
CXTEXE†	3	Carex texensis	Nt P-SEDGE	Texas Sedge
CXTIMI†	9	Carex timida◀	Nt P-SEDGE	Timid Sedge
CXTONR†	6	Carex tonsa var. rugosperma	Nt P-SEDGE	Wrinkle-Seeded Oak Sedge
CXTONT†	10	Carex tonsa var. tonsa	Nt P-SEDGE	Smooth-Fruited Oak Sedge
CXTORT†	9	Carex torta	Nt P-SEDGE	Twisted Sedge
CXTRIA†	9	Carex triangularis	Nt P-SEDGE	Triangular Sedge
CXTRIS†	3	Carex tribuloides var. sangamonensis◀	Nt P-SEDGE	Awl-Fruited Oval Sedge
CXTRIT†	3	Carex tribuloides var. tribuloides◀	Nt P-SEDGE	Awl-Fruited Oval Sedge
CXTRIC†	10	Carex trichocarpa	Nt P-SEDGE	Hairy-Fruited Sedge
CXTYPH†	7	Carex typhina	Nt P-SEDGE	Cat-Tail Sedge
CXUMBE†	6	Carex umbellata	Nt P-SEDGE	Umbel-Like Sedge
CXVESI†	9	Carex vesicaria var. monile	Nt P-SEDGE	Inflated Sedge
CXVIRE†	7	Carex virescens	Nt P-SEDGE	Ribbed Sedge
CXVULP†	3	Carex vulpinoidea	Nt P-SEDGE	Fox Sedge
CXWILL†	10	Carex willdenowii	Nt P-SEDGE	Willdenow's Sedge
CXWOOD†	10	Carex woodii	Nt P-SEDGE	Pretty Sedge
CARPCA†	6	Carpinus caroliniana	Nt TREE	Blue Beech
CARUCA†	*	CARUM CARVI	Ad B-FORB	Caraway
CARAQU	9	Carya aquatica	Nt TREE	Water Hickory
CARCOR	5	Carya cordiformis	Nt TREE	Bitternut Hickory
CARGLA	6	Carya glabra◀	Nt TREE	Pignut Hickory
CARILL	7	Carya illinoinensis	Nt TREE	Pecan

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CARLAC	7	Carya laciniosa	Nt TREE	Big Shellbark Hickory
CAROVL†	6	Carya ovalis◄	Nt TREE	Red Hickory
CAROVT†	4	Carya ovata	Nt TREE	Shagbark Hickory
CARPAL	8	Carya pallida	Nt TREE	Sand Hickory
CARTEX	5	Carya texana	Nt TREE	Black Hickory
CARTOM	5	Carya tomentosa	Nt TREE	Mockernut Hickory
CASDEN	*	CASTANEA DENTATA	Ad TREE	Chestnut
CASMOL	*	CASTANEA MOLLISSIMA	Ad TREE	Chinese Chestnut
CASPUO†	10	Castanea pumila var. ozarkensis	Nt TREE	Ozark Chinquapin
CASPUP†	10	Castanea pumila var. pumila	Nt TREE	Chinquapin
CASCOC	6	Castilleja coccinea	Nt A-FORB	Indian Paintbrush
CASPUR	10	Castilleja purpurea	Nt P-FORB	Purple Paintbrush
CASSES	10	Castilleja sessiliflora	Nt P-FORB	Downy Yellow Painted Cup
CATBIG	*	CATALPA BIGNONIOIDES	Ad TREE	Catalpa
CATOVA	*	CATALPA OVATA	Ad TREE	Chinese Catalpa
CATSPE	2	Catalpa speciosa	Nt TREE	Hardy Catalpa
CAUTHA	8	Caulophyllum thalictroides	Nt P-FORB	Blue Cohosh
CAYQUI	10	Cayaponia quinqueloba	Nt P-FORB	Silva Manso
CEAAME	7	Ceanothus americanus	Nt SHRUB	New Jersey Tea
CEAHER	8	Ceanothus herbaceus	Nt SHRUB	Inland New Jersey Tea
CELORB	*	CELASTRUS ORBICULATUS	Ad W-VINE	Oriental Bittersweet
CELSCA	3	Celastrus scandens	Nt W-VINE	Climbing Bittersweet
CELARG	*	CELOSIA ARGENTEA	Ad A-FORB	Cock's Comb
CELLAE	4	Celtis laevigata	Nt TREE	Sugarberry
CELOCC	3	Celtis occidentalis	Nt TREE	Hackberry
CELPUM	6	Celtis pumila	Nt TREE	Dwarf Hackberry
CENCIL	*	CENCHRUS CILIARIS	Ad P-GRASS	Buffel Grass
CENLON	0	Cenchrus longispinus	Nt A-GRASS	Common Sandbur
CENSPI	3	Cenchrus spinifex◄	Nt A-GRASS	Prairie Sandbur
CENAME	6	Centaurea americana	Nt A-FORB	Basket Flower
CENCYA	*	CENTAUREA CYANUS	Ad A-FORB	Bachelor's Button
CENDIF	*	CENTAUREA DIFFUSA	Ad A-FORB	Spreading Star Thistle
CENDIL	*	CENTAUREA DILUTA	Ad A-FORB	Star Thistle
CENMEL	*	CENTAUREA MELITENSIS	Ad A-FORB	Malta Star Thistle
CENNIA†	*	CENTAUREA NIGRA	Ad P-FORB	Black Knapweed
CENNIS†	*	CENTAUREA NIGRESCENS	Ad P-FORB	Tyrol Knapweed
CENREP	*	CENTAUREA REPENS	Ad P-FORB	Russian Knapweed
CENSOL	*	CENTAUREA SOLSTITIALIS	Ad A-FORB	Yellow Star Thistle
CENSTO	*	CENTAUREA STOEBE subsp. MICRANTHOS	Ad P-FORB	Spotted Knapweed

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CENVIR	10	Centrosema virginianum	Nt P-FORB	Spurred Butterfly Pea
CEPOCC	3	Cephalanthus occidentalis	Nt SHRUB	Buttonbush
CERARV	10	Cerastium arvense subsp. strictum	Nt P-FORB	Field Chickweed
CERBRT†	*	CERASTIUM BRACHYPETALUM	Ad A-FORB	Gray Chickweed
CERBRO†	3	Cerastium brachypodum	Nt A-FORB	Short-Stalked Chickweed
CERDIF	*	CERASTIUM DIFFUSUM	Ad A-FORB	Four-Stamened Chickweed
CERDUB	*	CERASTIUM DUBIUM	Ad A-FORB	Doubtful Chickweed
CERFON	*	CERASTIUM FONTANUM subsp. VULGARE	Ad P-FORB	Mouse-Ear Chickweed
CERGLO	*	CERASTIUM GLOMERATUM	Ad A-FORB	Clammy Chickweed
CERNUT	2	Cerastium nutans	Nt A-FORB	Nodding Chickweed
CERPUM	*	CERASTIUM PUMILUM	Ad A-FORB	Dwarf Chickweed
CERSEM	*	CERASTIUM SEMIDECANDRUM	Ad A-FORB	Small Mouse-Ear Chickweed
CERVEL	4	Cerastium velutinum	Nt P-FORB	Showy Field Chickweed
CERTES	*	CERATOCEPHALUS TESTICULATUS	Ad A-FORB	Bur-Buttercup
CERDEM	5	Ceratophyllum demersum	Nt P-FORB	Coontail
CERECH	9	Ceratophyllum echinatum	Nt P-FORB	Spiny Hornwort
CERPLU	*	CERATOSTIGMA PLUMBAGINOIDES	Ad P-FORB	Plumbago
CERCAN	3	Cercis canadensis	Nt TREE	Redbud
CHASPE	*	CHAENOMELES SPECIOSA	Ad SHRUB	Flowering Quince
CHAMIN	*	CHAENORRHINUM MINUS	Ad A-FORB	Small Snapdragon
CHAPRO	2	Chaerophyllum procumbens	Nt A-FORB	Wild Chervil
CHATAI	3	Chaerophyllum tainturieri	Nt A-FORB	Southern Chervil
CHAAST	10	Chaetopappa asteroides	Nt A-FORB	Least Daisy
CHAFAS	2	Chamaecrista fasciculata	Nt A-FORB	Partridge Pea
CHANIC	2	Chamaecrista nictitans	Nt A-FORB	Wild Sensitive Plant
CHALAT	4	Chasmanthium latifolium	Nt P-GRASS	Spike Grass
CHALAX	10	Chasmanthium laxum	Nt P-GRASS	Slender Spike Grass
CHASES	10	Chasmanthium sessilifolium	Nt P-GRASS	Sessile-Flowered Spike Grass
CHEALA	10	Cheilanthes alabamensis	Nt FERN	Alabama Lip-Fern
CHEFEE	8	Cheilanthes feei	Nt FERN	Slender Lip Fern
CHELAN	7	Cheilanthes lanosa	Nt FERN	Hairy Lip-Fern
CHETOM	10	Cheilanthes tomentosa	Nt FERN	Wooly-Lip-Fern
CHEMAJ	*	CHELIDONIUM MAJUS	Ad B-FORB	Celandine
CHEGLB†	8	Chelone glabra	Nt P-FORB	Turtlehead
CHEOBL	10	Chelone obliqua	Nt P-FORB	Pink Turtlehead
CHEALB	*	CHENOPODIUM ALBUM	Ad A-FORB	Lamb's Quarters
CHEAMB	*	CHENOPODIUM AMBROSIOIDES	Ad A-FORB	Mexican Tea
CHEBER	1	Chenopodium berlandieri	Nt A-FORB	Pitseed Goosefoot

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CHEBOT	*	CHENOPODIUM BOTRYS	Ad A-FORB	Jerusalem Oak
CHEBUS	2	Chenopodium bushianum	Nt A-FORB	Bush's Goosefoot
CHECAP	*	CHENOPODIUM CAPITATUM	Ad A-FORB	Strawberry Blite
CHEDES	*	CHENOPODIUM DESICCATUM	Ad A-FORB	Narrow-Leaved Goosefoot
CHEFIC	*	CHENOPODIUM FICIFOLIUM	Ad A-FORB	Fig-Leaved Goosefoot
CHEGLC†	*	CHENOPODIUM GLAUCUM	Ad A-FORB	Oak-Leaved Goosefoot
CHEINC	*	CHENOPODIUM INCANUM	Ad A-FORB	Hoary Goosefoot
CHEMIS	1	Chenopodium missouriense	Nt A-FORB	Missouri Goosefoot
CHEMUR	*	CHENOPODIUM MURALE	Ad A-FORB	Nettle-Leaved Goosefoot
CHEOPU	*	CHENOPODIUM OPULIFOLIUM	Ad A-FORB	Broad-Leaved Lamb's Quarters
CHEPAL	2	Chenopodium pallescens	Nt A-FORB	Pale Goosefoot
CHEPRA	0	Chenopodium pratericola◀	Nt A-FORB	Desert Goosefoot
CHEPUM	*	CHENOPODIUM PUMILIO	Ad A-FORB	Small Crumbweed
CHERUB	*	CHENOPODIUM RUBRUM	Ad A-FORB	Red Goosefoot
CHESIM	2	Chenopodium simplex	Nt A-FORB	Maple-Leaved Goosefoot
CHESTA	3	Chenopodium standleyanum	Nt A-FORB	Woodland Goosefoot
CHESTR	4	Chenopodium strictum var. glaucophyllum	Nt A-FORB	Late Goosefoot
CHEURB	*	CHENOPODIUM URBICUM	Ad A-FORB	City Goosefoot
CHEWAT	*	CHENOPODIUM WATSONII	Ad A-FORB	Watson's Goosefoot
CHIVIR	10	Chionanthus virginicus	Nt TREE	Fringe Tree
CHLVER	0	Chloris verticillata	Nt P-GRASS	Windmill Grass
CHLVIR	*	CHLORIS VIRGATA	Ad A-GRASS	Feather Finger Grass
CHOTEN	*	CHORISPORA TENELLA	Ad A-FORB	Purple Rocket
CICINT	*	CICHORIUM INTYBUS	Ad P-FORB	Chicory
CICMAC	5	Cicuta maculata	Nt B-FORB	Water Hemlock
CINARU	7	Cinna arundinacea	Nt P-GRASS	Common Wood Reed
CIRCAD†	2	Circaea canadensis	Nt P-FORB	Enchanter's Nightshade
CIRALT	4	Cirsium altissimum	Nt P-FORB	Tall Thistle
CIRARV	*	CIRSIUM ARVENSE	Ad P-FORB	Canada Thistle
CIRCAS†	*	CIRSIUM CANESCENS	Ad B-FORB	Platte Thistle
CIRCAR	8	Cirsium carolinianum	Nt B-FORB	Carolina Thistle
CIRDIS	3	Cirsium discolor	Nt P-FORB	Field Thistle
CIRMUT	10	Cirsium muticum	Nt B-FORB	Swamp Thistle
CIRTEX	*	CIRSIUM TEXANUM	Ad P-FORB	Texas Thistle
CIRUND	5	Cirsium undulatum	Nt P-FORB	Wavy-Leaved Thistle
CIRVUL	*	CIRSIUM VULGARE	Ad B-FORB	Bull Thistle
CISTRI	10	Cissus trifoliata	Nt W-VINE	Marine Vine
CITLAN	*	CITRULLUS LANATUS	Ad A-FORB	Watermelon
CITTRI	*	CITRUS TRIFOLIATA	Ad SHRUB	Hardy Orange

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CLAMAR	*	CLADIUM MARISCUS subsp. JAMAICENSE◄	Ad P-SEDGE	Sawgrass
CLAKEN	10	Cladrastis kentukea	Nt TREE	Yellow Wood
CLAPER	*	CLAYTONIA PERFOLIATA	Ad A-FORB	Miner's Lettuce
CLAVIR	3	Claytonia virginica	Nt P-FORB	Spring Beauty
CLECAT	7	Clematis catesbyana	Nt W-VINE	Satincurls
CLECRI	8	Clematis crispa	Nt W-VINE	Swamp Leather Flower
CLEFRE	10	Clematis fremontii	Nt W-VINE	Fremont's Leather Flower
CLEPIT	6	Clematis pitcheri	Nt W-VINE	Leather Flower
CLETER	*	CLEMATIS TERNIFLORA	Ad W-VINE	Sweet Autumn Clematis
CLEVER	9	Clematis versicolor	Nt W-VINE	Small Leather Flower
CLEVIO	10	Clematis viorna	Nt W-VINE	Vase Vine
CLEVIR	3	Clematis virginiana	Nt W-VINE	Virgin's Bower
CLEHAS	*	CLEOME HASSLERIANA	Ad A-FORB	Spider Flower
CLESER	2	Cleome serrulata	Nt A-FORB	Rocky Mountain Bee Plant
CLIACI	*	CLINOPODIUM ACINOS	Ad A-FORB	Mother-Of-Thyme
CLIARK	7	Clinopodium arkansanum	Nt P-FORB	Low Calamint
CLIMAR	7	Clitoria mariana	Nt P-FORB	Butterfly Pea
COCCAR	5	Cocculus carolinus	Nt W-VINE	Carolina Snailseed
COEVIR	10	Coeloglossum viride	Nt P-FORB	Frog Orchid
COECYL	9	Coelorachis cylindrica	Nt P-GRASS	Joint Grass
COLVER	7	Collinsia verna	Nt A-FORB	Blue-Eyed Mary
COLVIO	8	Collinsia violacea	Nt A-FORB	Violet Collinsia
COLCAN	9	Collinsonia canadensis	Nt P-FORB	Richweed
COLLIN	*	COLLOMIA LINEARIS	Ad A-FORB	Slender Gilia
COMUMB	7	Comandra umbellata	Nt P-FORB	False Toadflax
COMCAR	*	COMMELINA CAROLINIANA	Ad A-FORB	Carolina Dayflower
COMCOM	*	COMMELINA COMMUNIS	Ad A-FORB	Common Dayflower
COMDIF	*	COMMELINA DIFFUSA	Ad A-FORB	Creeping Dayflower
COMERE	4	Commelina erecta	Nt P-FORB	Narrow-Leaved Dayflower
COMVIR	5	Commelina virginica	Nt P-FORB	Virginia Dayflower
CONMAC	*	CONIUM MACULATUM	Ad B-FORB	Poison Hemlock
CONCOE	3	Conoclinium coelestinum	Nt P-FORB	Mistflower
CONORI	*	CONRINGIA ORIENTALIS	Ad A-FORB	Hare's Ear Mustard
CONMAJ	*	CONVALLARIA MAJALIS	Ad P-FORB	Lily Of The Valley
CONARV	*	CONVOLVULUS ARVENSIS	Ad P-FORB	Field Bindweed
CONCAC†	0	Conyza canadensis var. canadensis	Nt A-FORB	Horseweed
CONCAP†	7	Conyza canadensis var. pusilla	Nt A-FORB	Small Canada Fleabane
CONRAM	1	Conyza ramosissima	Nt A-FORB	Dwarf Fleabane
CORODO	6	Corallorhiza odontorhiza	Nt P-FORB	Late Coral Root

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CORWIS	7	Corallorhiza wisteriana	Nt P-FORB	Wister's Coral Root
CORGRA	6	Coreopsis grandiflora	Nt P-FORB	Large-Flowered Coreopsis
CORLAN	5	Coreopsis lanceolata	Nt P-FORB	Sand Coreopsis
CORPAL	7	Coreopsis palmata	Nt P-FORB	Prairie Coreopsis
CORPUB	7	Coreopsis pubescens	Nt P-FORB	Star Tickseed
CORTIN	1	Coreopsis tinctoria	Nt A-FORB	Golden Coreopsis
CORTRI	6	Coreopsis tripteris	Nt P-FORB	Tall Coreopsis
CORSAT	*	CORIANDRUM SATIVUM	Ad A-FORB	Coriander
CORIAM†	5	Corispermum americanum	Nt A-FORB	Small Bugseed
CORIPA†	5	Corispermum pallassii	Nt A-FORB	Common Bugseed
CORIVI†	5	Corispermum villosum	Nt A-FORB	Eastern Bugseed
CORALT	8	Cornus alternifolia	Nt TREE	Pagoda Dogwood
CORAMO	5	Cornus amomum subsp. obliqua◥	Nt SHRUB	Pale Dogwood
CORDRU	2	Cornus drummondii	Nt SHRUB	Rough-Leaved Dogwood
CORFLO	5	Cornus florida	Nt TREE	Flowering Dogwood
CORFOF†	6	Cornus foemina subsp. foemina◥	Nt SHRUB	Stiff Dogwood
CORFOR†	3	Cornus foemina subsp. racemosa◥	Nt SHRUB	Gray Dogwood
CORAUA†	3	Corydalis aurea subsp. aurea	Nt A-FORB	Golden Corydalis
CORAUO†	5	Corydalis aurea subsp. occidentalis	Nt B-FORB	Golden Corydalis
CORCRY	7	Corydalis crystallina	Nt B-FORB	Mealy Corydalis
CORFLA	3	Corydalis flavula	Nt B-FORB	Pale Corydalis
CORMIA†	10	Corydalis micrantha subsp. australis	Nt B-FORB	Hale's Corydalis
CORMIM†	4	Corydalis micrantha subsp. micrantha	Nt B-FORB	Small-Flowered Corydalis
CORYAM†	4	Corylus americana	Nt SHRUB	American Hazelnut
COSBIP	*	COSMOS BIPINNATUS	Ad A-FORB	Common Cosmos
COSPAR	*	COSMOS PARVIFLORUS	Ad A-FORB	Small-Flowered Cosmos
COSSUL	*	COSMOS SULPHUREUS	Ad A-FORB	Sulphur Cosmos
COTTIN	*	COTA TINCTORIA	Ad P-FORB	Yellow Chamomile
COTOBO	9	Cotinus obovatus	Nt TREE	American Smoke Tree
COTACU	*	COTONEASTER ACUTIFOLIUS	Ad SHRUB	Peking Cotoneaster
CRABER	4	Crataegus berberifolia	Nt TREE	Barberry-Leaved Hawthorn
CRABIL	5	Crataegus biltmoreana	Nt TREE	Biltmore Hawthorn
CRACAL	6	Crataegus calpodendron	Nt TREE	Sugar Hawthorn
CRACOC	4	Crataegus coccinioides	Nt TREE	Kansas Hawthorn
CRACOL	4	Crataegus collina◥	Nt TREE	Hillside Hawthorn
CRACRU	3	Crataegus crus-galli	Nt TREE	Cockspur Hawthorn
CRAFEC	3	Crataegus fecunda	Nt TREE	Fruitful Hawthorn
CRAGAT	5	Crataegus gattingeri	Nt TREE	Gatinger's Hawthorn
CRALAN	6	Crataegus lanuginosa	Nt TREE	Woolly Hawthorn

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CRAMAC	4	Crataegus macracantha	Nt TREE	Largethorn Hawthorn
CRAMAG†	3	Crataegus margarettae	Nt TREE	Margarets Hawthorn
CRAMAS†	9	Crataegus marshallii	Nt TREE	Parsley Hawthorn
CRAMOL	4	Crataegus mollis	Nt TREE	Downy Hawthorn
CRANEO	5	Crataegus neobushii	Nt TREE	St. Clair Hawthorn
CRAPAD	7	Crataegus padifolia	Nt TREE	Bird-Cherry Hawthorn
CRAPHA	5	Crataegus phaenopyrum	Nt TREE	Washington Thorn
CRAPRU	3	Crataegus pruinosa	Nt TREE	Frosted Hawthorn
CRAREV	4	Crataegus reverchonii	Nt TREE	Reverchon Hawthorn
CRARUB	6	Crataegus rubella	Nt TREE	Rosy Hawthorn
CRASCH	8	Crataegus schuettei	Nt TREE	Schuette Hawthorn
CRASIC	4	Crataegus sicca	Nt TREE	Smooth Hawthorn
CRASPA	9	Crataegus spathulata	Nt TREE	Littlehip Hawthorn
CRASUC	3	Crataegus succulenta	Nt TREE	Fleshy Hawthorn
CRATEX	10	Crataegus texana	Nt TREE	Texas Red Hawthorn
CRAUNI	7	Crataegus uniflora	Nt TREE	One-Flower Hawthorn
CRAVIR	5	Crataegus viridis	Nt TREE	Green Haw
CRECAP	*	CREPIS CAPILLARIS	Ad A-FORB	Hawk's Beard
CREPUL	*	CREPIS PULCHRA	Ad B-FORB	Small-Flowered Hawk's Beard
CRESET	*	CREPIS SETOSA	Ad A-FORB	Bristly Hawk's Beard
CRETEC	*	CREPIS TECTORUM	Ad A-FORB	Sand Rushfoil
CROSAG	5	Crotalaria sagittalis	Nt A-FORB	Rattlebox
CROSPE	*	CROTALARIA SPECTABILIS	Ad A-FORB	Showy Crotalaria
CROCAC†	0	Croton capitatus var. capitatus	Nt A-FORB	Hogwort
CROCAL†	2	Croton capitatus var. lindheimeri	Nt A-FORB	Woolly Croton
CROGLA	1	Croton glandulosus var. septentrionalis	Nt A-FORB	Sand Croton
CROLIN	*	CROTON LINDHEIMERIANUS	Ad A-FORB	Lindheimer's Croton
CROMIC	8	Croton michauxii	Nt A-FORB	Slender Rushfoil
CROMON	2	Croton monanthogynus	Nt A-FORB	Prairie Tea
CROTEX	*	CROTON TEXENSIS	Ad A-FORB	Skunk Weed
CROWIL	4	Croton wildenowii	Nt A-FORB	Common Rushfoil
CRYSCH	*	CRYPSIS SCHOENOIDES	Ad A-GRASS	False Timothy
CRYCAN	2	Cryptotaenia canadensis	Nt P-FORB	Honewort
CUBCON	7	Cubelium concolor	Nt P-FORB	Green Violet
CUCMEL	*	CUCUMIS MELO	Ad A-FORB	Muskmelon
CUCSAT	*	CUCUMIS SATIVUS	Ad A-FORB	Cucumber
CUCFOE	*	CUCURBITA FOETIDISSIMA	Ad P-FORB	Missouri Gourd
CUCPOV†	*	CUCURBITA PEPO var. OVIFERA	Ad A-FORB	Ornamental Gourd
CUCPOZ†	2	Cucurbita pepo var. ozarkana	Nt A-FORB	Yellow-Flowered Gourd

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CUNORI	6	Cunila origanoides	Nt P-FORB	Dittany
CUPVIS	4	Cuphea viscosissima	Nt A-FORB	Waxweed
CUSCAM	4	Cuscuta campestris	Nt A-FORB	Prairie Dodder
CUSCEP	6	Cuscuta cephalanthi	Nt A-FORB	Buttonbush Dodder
CUSCOM	7	Cuscuta compacta	Nt A-FORB	Compact Dodder
CUSCOR	7	Cuscuta coryli	Nt A-FORB	Hazel Dodder
CUSCUS	5	Cuscuta cuspidata	Nt A-FORB	Cusp Dodder
CUSGLO	5	Cuscuta glomerata	Nt A-FORB	Rope Dodder
CUSGRO	3	Cuscuta gronovii	Nt A-FORB	Common Dodder
CUSIND	2	Cuscuta indecora	Nt A-FORB	Large Alfalfa Dodder
CUSOBT	8	Cuscuta obtusiflora var. glandulosa	Nt P-FORB	Peruvian Dodder
CUSPEN	5	Cuscuta pentagona	Nt A-FORB	Field Dodder
CUSPOL	7	Cuscuta polygonorum	Nt A-FORB	Knotweed Dodder
CYCXAN	0	Cyclachaena xanthifolia	Nt A-FORB	Burweed Marsh Elder
CYCATR	4	Cycloloma atriplicifolium	Nt A-FORB	Winged Pigweed
CYLIMB	*	CYLINDROPUNTIA IMBRICATA	Ad SHRUB	Tree Cholla
CYMMUR	*	CYMBALARIA MURALIS	Ad P-FORB	Kenilworth Ivy
CYNLAE	0	Cynanchum laeve	Nt P-FORB	Bluevine
CYNLOU	*	CYNANCHUM LOUISEAE	Ad P-FORB	Black Swallowwort
CYNDAC	*	CYNODON DACTYLON	Ad P-GRASS	Bermuda Grass
CYNCRE	*	CYNOGLOSSUM CRETICUM	Ad A-FORB	Blue Hound's Tongue
CYNOFF	*	CYNOGLOSSUM OFFICINALE	Ad B-FORB	Common Hound's Tongue
CYNVIR	6	Cynoglossum virginianum	Nt P-FORB	Wild Comfrey
CYNDIG	7	Cynosciadium digitatum	Nt A-FORB	Pinnate Dog-Celery
CYNECH	*	CYNOSURUS ECHINATUS	Ad A-GRASS	Dog's Tail Grass
CYPACU	3	Cyperus acuminatus	Nt A-SEDGE	Short-Pointed Cyperus
CYPBIP	6	Cyperus bipartitus	Nt A-SEDGE	Brook Sedge
CYPCOM	0	Cyperus compressus	Nt A-SEDGE	Coco Grass
CYPCRO	10	Cyperus croceus	Nt P-SEDGE	Bladwin Flatsedge
CYPDIA	6	Cyperus diandrus	Nt A-SEDGE	Umbrella Flatsedge
CYPDIF	*	CYPERUS DIFFORMIS	Ad A-SEDGE	Variable Flatsedge
CYPECH	3	Cyperus echinatus	Nt P-SEDGE	Ball Sedge
CYPERY	2	Cyperus erythrorhizos	Nt A-SEDGE	Red-Rooted Sedge
CYPESC	0	Cyperus esculentus	Nt P-SEDGE	Chufa
CYPFLN†	5	Cyperus flavescens var. poiformis	Nt A-SEDGE	Yellow Flatsedge
CYPFLC†	*	CYPERUS FLAVICOMIS	Ad A-SEDGE	White-Edged Cyperus
CYPFUS	*	CYPERUS FUSCUS	Ad A-SEDGE	Brown Flatsedge
CYPGRA	9	Cyperus grayoides	Nt P-SEDGE	Illinois Flatsedge
CYPHYS	9	Cyperus hystricinus	Nt P-SEDGE	Bristly Flatsedge

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
CYPIRI	*	CYPERUS IRIA	Ad A-SEDGE	Iria Flatsedge
CYPLAN	5	Cyperus lancastriensis	Nt P-SEDGE	Many-Flowered Flatsedge
CYPLUL†	4	Cyperus lupulinus subsp. lupulinus	Nt P-SEDGE	Slender Flatsedge
CYPLUM†	4	Cyperus lupulinus subsp. macilentus	Nt P-SEDGE	Slender Flatsedge
CYPODO	3	Cyperus odoratus	Nt A-SEDGE	Fragrant Flatsedge
CYPPLU	10	Cyperus plukenettii	Nt P-SEDGE	Plunkenet's Cyperus
CYPPOL	8	Cyperus polystachyos var. texensis	Nt A-SEDGE	Many-Spike Flatsedge
CYPPSE	5	Cyperus pseudovegetus	Nt P-SEDGE	Green Flatsedge
CYPREF	6	Cyperus refractus	Nt P-SEDGE	Reflexed Flatsedge
CYPREX†	6	Cyperus retroflexus	Nt P-SEDGE	One-Flowered Flatsedge
CYPREC†	8	Cyperus retrofractus	Nt P-SEDGE	Rough Flatsedge
CYPRER†	*	CYPERUS RETRORSUS	Ad P-SEDGE	Pine Barrens Flatsedge
CYPROT	*	CYPERUS ROTUNDUS	Ad P-SEDGE	Nut Grass
CYPSCH	7	Cyperus schweinitzii	Nt P-SEDGE	Rough Sand Flatsedge
CYPSET	5	Cyperus setigerus	Nt P-SEDGE	Leon Flatsedge
CYPSQU	3	Cyperus squarrosus	Nt A-SEDGE	Awned Flatsedge
CYPSTR	1	Cyperus strigosus	Nt P-SEDGE	Straw-Colored Flatsedge
CYPPAR†	8	Cypripedium calceolus var. parviflorum	Nt P-FORB	Small Yellow Lady's Slipper
CYPPUB†	8	Cypripedium calceolus var. pubescens	Nt P-FORB	Large Yellow Lady's Slipper
CYPCAN	10	Cypripedium candidum	Nt P-FORB	White Lady's Slipper
CYPREG	10	Cypripedium reginae	Nt P-FORB	Showy Lady's Slipper
CYSBUL	8	Cystopteris bulbifera	Nt FERN	Bulblet Fern
CYSPRO	5	Cystopteris protrusa	Nt FERN	Southern Fern
CYSTES†	8	Cystopteris tennesseensis	Nt FERN	Tennessee Bladder Fern
CYSTEU†	10	Cystopteris tenuis	Nt FERN	Fragile Fern
DACGLO	*	DACTYLIS GLOMERATA	Ad P-GRASS	Orchard Grass
DALCAN	8	Dalea candida	Nt P-FORB	White Prairie Clover
DALENN	10	Dalea enneandra	Nt P-FORB	Nine-Anthered Prairie Clover
DALGAT	10	Dalea gattingeri	Nt P-FORB	Glade Prairie Clover
DALLEP	7	Dalea leporina	Nt A-FORB	Foxtail Dalea
DALMUL	10	Dalea multiflora	Nt P-FORB	Round-Headed Prairie Clover
DALPUR	8	Dalea purpurea	Nt P-FORB	Purple Prairie Clover
DALVIL	*	DALEA VILLOSA	Ad P-FORB	Silky Prairie Clover
DANSPI	3	Danthonia spicata	Nt P-GRASS	Poverty Oat Grass
DASMAC	5	Dasistoma macrophyllum	Nt P-FORB	Mullein Foxglove
DATINO	*	DATURA INOXIA	Ad A-FORB	Angel's Trumpet
DATSTR	*	DATURA STRAMONIUM	Ad A-FORB	Jimson Weed
DATWRI	*	DATURA WRIGHTII	Ad A-FORB	Sacred Thorn-Apple

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
DAUCAR	*	DAUCUS CAROTA	Ad B-FORB	Queen Anne's Lace
DAUPUS	4	Daucus pusillus	Nt B-FORB	Small Wild Carrot
DECVER	10	Decodon verticillatus	Nt SHRUB	Swamp Loosestrife
DELAJA	*	DELPHINIUM AJACIS	Ad A-FORB	Rocket Larkspur
DELCAC†	7	Delphinium carolinianum subsp. carolinianum	Nt P-FORB	Carolina Larkspur
DELCAV†	6	Delphinium carolinianum subsp. virescens	Nt P-FORB	Prairie Larkspur
DELCON	*	DELPHINIUM CONSOLIDA	Ad A-FORB	Forking Larkspur
DELEXA	10	Delphinium exaltatum	Nt P-FORB	Tall Larkspur
DELTRE	10	Delphinium treleasei	Nt P-FORB	Trelease's Larkspur
DELTRI	6	Delphinium tricorne	Nt P-FORB	Dwarf Larkspur
DENPUN	10	Dennstaedtia punctilobula	Nt FERN	Hay-Scented Fern
DEPACR	10	Deparia acrostichoides	Nt FERN	Silvery Spleenwort
DESPIB†	2	Descurainia pinnata subsp. brachycarpa	Nt A-FORB	Green Tansy Mustard
DESPIP†	6	Descurainia pinnata subsp. pinnata	Nt A-FORB	Gray Tansy Mustard
DESSOP	*	DESCURAINIA SOPHIA	Ad A-FORB	Flixweed
DESAIL†	3	Desmanthus illinoensis	Nt P-FORB	Illinois Bundle Flower
DESLEP	*	DESMANTHUS LEPTOLOBUS	Ad P-FORB	Creeping Bundle flower
DESHUM	8	Desmodium × humifusum	Nt P-FORB	Trailing Tick Trefoil
DESCAD†	4	Desmodium canadense	Nt P-FORB	Showy Tick Trefoil
DESCAS†	5	Desmodium canescens	Nt P-FORB	Hoary Tick Trefoil
DESCIL	5	Desmodium ciliare	Nt P-FORB	Hairy Tick Trefoil
DESCUS	5	Desmodium cuspidatum	Nt P-FORB	Bracted Tick Trefoil
DESGLA	3	Desmodium glabellum	Nt P-FORB	Dilleni's Tick Trefoil
DESOIL†	6	Desmodium illinoense	Nt P-FORB	Illinois Tick Trefoil
DESLAE	7	Desmodium laevigatum	Nt P-FORB	Smooth Tick Trefoil
DESMAR	5	Desmodium marilandicum	Nt P-FORB	Small-Leaved Tick Trefoil
DESNUT	7	Desmodium nuttallii	Nt P-FORB	Nuttall's Tick Trefoil
DESOBT	6	Desmodium obtusum	Nt P-FORB	Stiff Tick Trefoil
DESOCH	10	Desmodium ochroleucum	Nt P-FORB	Cream-Flowered Tick Trefoil
DESPAN	3	Desmodium paniculatum	Nt P-FORB	Panicled Tick Trefoil
DESPER	3	Desmodium perplexum	Nt P-FORB	Confusing Trefoil
DESROT	6	Desmodium rotundifolium	Nt P-FORB	Round-Leaved Tick Trefoil
DESSES	5	Desmodium sessilifolium	Nt P-FORB	Sessile-Leaved Tick Trefoil
DESSTR	10	Desmodium strictum	Nt P-FORB	Sand Tick Trefoil
DESVIR	10	Desmodium viridiflorum	Nt P-FORB	Velvetleaf Tick Trefoil
DIAARM	*	DIANTHUS ARMERIA	Ad A-FORB	Deptford Pink
DIABAR	*	DIANTHUS BARBATUS	Ad P-FORB	Sweet William
DIADEL	*	DIANTHUS DELTOIDES	Ad P-FORB	Maiden Pink

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
DIAPLU	*	DIANTHUS PLUMARIUS	Ad P-FORB	Garden Pink
DIAPRO	*	DIAPERIA PROLIFERA	Ad A-FORB	Pygmy Cudweed
DIAAME	9	Diarrhena americana	Nt P-GRASS	American Beak Grass
DIAOBO	6	Diarrhena obovata	Nt P-GRASS	Obovate Beak Grass
DICCAN	9	Dicentra canadensis	Nt P-FORB	Squirrel Corn
DICCUC	6	Dicentra cucullaria	Nt P-FORB	Dutchman's Breeches
DICANG	7	Dichanthelium angustifolium ◀	Nt P-GRASS	Needle-Leaved Panic Grass
DICANN	10	Dichanthelium annulum	Nt P-GRASS	Ringed Panic Grass
DICASH	7	Dichanthelium ashei ◀	Nt P-GRASS	Ashe's Panic Grass
DICBIC	6	Dichanthelium bicknellii ◀	Nt P-GRASS	Bicknell's Panic Grass
DICBOS	5	Dichanthelium boscii	Nt P-GRASS	Bosc's Panic Grass
DICCLA	4	Dichanthelium clandestinum	Nt P-GRASS	Deer Tongue Grass
DICCOL	8	Dichanthelium columbianum ◀	Nt P-GRASS	Hemlock Panic Grass
DICCOS†	8	Dichanthelium commonsianum	Nt P-GRASS	Common's Panic Grass
DICCOM	7	Dichanthelium commutatum var. commutatum	Nt P-GRASS	Variable Panic Grass
DICDEP	4	Dichanthelium depauperatum	Nt P-GRASS	Starved Panic Grass
DICDIB†	6	Dichanthelium dichotomum var. barbulatum ◀	Nt P-GRASS	Forked Panic Grass
DICDID†	8	Dichanthelium dichotomum var. dichotomum	Nt P-GRASS	Forked Panic Grass
DICDIY†	10	Dichanthelium dichotomum var. yadkinense ◀	Nt P-GRASS	Yadkin Panic Grass
DICIMP	7	Dichanthelium implicatum ◀	Nt P-GRASS	Hairy Panic Grass
DICJOO	7	Dichanthelium joorii ◀	Nt P-GRASS	Joor's Panic Grass
DICLAN	2	Dichanthelium lanuginosum ◀	Nt P-GRASS	Wooly Panic Grass
DICLAT	7	Dichanthelium latifolium	Nt P-GRASS	Broad-Leaved Panic Grass
DICLAX	6	Dichanthelium laxiflorum	Nt P-GRASS	Lax-Flowered Panic Grass
DICLEI	10	Dichanthelium leibergii	Nt P-GRASS	Prairie Panic Grass
DICLID†	3	Dichanthelium lindheimeri ◀	Nt P-GRASS	Lindheimer's Panic Grass
DICLIL†	5	Dichanthelium linearifolium var. linearifolium	Nt P-GRASS	Slender-Leaved Panic Grass
DICLON	4	Dichanthelium longiligulatum ◀	Nt P-GRASS	Coastal Plain Panic Grass
DICMAL	5	Dichanthelium malacophyllum	Nt P-GRASS	Soft-Leaved Panic Grass
DICMIC	7	Dichanthelium microcarpon	Nt P-GRASS	Small-Fruited Panic Grass
DICNIT	10	Dichanthelium nitidum	Nt P-GRASS	Shining Panic Grass
DICOLO†	6	Dichanthelium oligosanthes var. oligosanthes	Nt P-GRASS	Few-Flowered Panic Grass
DICOLS†	4	Dichanthelium oligosanthes var. scribnerianum	Nt P-GRASS	Scribner's Panic Grass
DICPER	9	Dichanthelium perlongum ◀	Nt P-GRASS	Long-Stalked Panic Grass
DICPOL	6	Dichanthelium polyanthes ◀	Nt P-GRASS	Many-Flowered Panic Grass
DICPRA	9	Dichanthelium praecocius ◀	Nt P-GRASS	Early-Branching Panic Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
DICRAV	7	Dichanthelium ravenelii	Nt P-GRASS	Ravenel's Panic Grass
DICSCO	6	Dichanthelium scoparium	Nt P-GRASS	Velvety Panic Grass
DICSPH	5	Dichanthelium sphaerocarpon	Nt P-GRASS	Round-Fruited Panic Grass
DICVIL	6	Dichanthelium villosissimum◀	Nt P-GRASS	White-Haired Panic Grass
DICWER†	7	Dichanthelium werneri◀	Nt P-GRASS	Werner's Panic Grass
DICCON	*	DICHELOSTEMMA CONGESTUM	Ad P-FORB	Garden Bluebells
DICCAR	*	DICHONDRA CAROLINENSIS◀	Ad P-FORB	Carolina Ponyfoot
DICBRA	6	Dicliptera brachiata	Nt A-FORB	Wild Mudwort
DICALB	*	DICTAMNUS ALBUS	Ad P-FORB	Gas Plant
DIDDIA	7	Didiplis diandra	Nt P-FORB	Water Purslane
DIGCIL	*	DIGITARIA CILIARIS	Ad A-GRASS	Southern Crab Grass
DIGCOG	3	Digitaria cognata	Nt P-GRASS	Fall Witch Grass
DIGFIL	3	Digitaria filiformis	Nt A-GRASS	Slender Crab Grass
DIGISC	*	DIGITARIA ISCHAEMUM	Ad A-GRASS	Smooth Crab Grass
DIGSAN	*	DIGITARIA SANGUINALIS	Ad A-GRASS	Hairy Crab Grass
DIGVIO	*	DIGITARIA VIOLASCENS	Ad A-GRASS	Violet Crab Grass
DIODTE†	2	Diodia teres	Nt A-FORB	Buttonweed
DIODVI†	5	Diodia virginiana	Nt P-FORB	Large Buttonweed
DIOOPP	*	DIOSCOREA OPPOSITIFOLIA	Ad P-FORB	Chinese Yam
DIOQUA	5	Dioscorea quaternata	Nt P-FORB	Four-Leaf Yam
DIOVIL	5	Dioscorea villosa	Nt P-FORB	Wild Yam
DIOSVI†	3	Diospyros virginiana	Nt TREE	Persimmon
DIPPYC	10	Diplazium pycnocarpon	Nt FERN	Narrow-Leaved Spleenwort
DIPMUR	*	DIPLOTAXIS MURALIS	Ad A-FORB	Wall Rocket
DIPFUL	*	DIPSACUS FULLONUM	Ad B-FORB	Common Teasel
DIPLAC	*	DIPSACUS LACINIATUS	Ad B-FORB	Cut-Leaved Teasel
DIRPAL	8	Dirca palustris◀	Nt SHRUB	Leatherwood
DISSPP†	10	Distichlis spicata var. spicata	Nt P-GRASS	Seashore Salt Grass
DISSPT†	*	DISTICHLIS SPICATA var. STRICTA	Ad P-GRASS	Inland Salt Grass
DOEUMB	10	Doellingeria umbellata var. pubens	Nt P-FORB	Flat-Top Aster
DRAAPR	10	Draba aprica	Nt A-FORB	Whitlow Grass
DRABRA	0	Draba brachycarpa	Nt A-FORB	Short-Fruited Whitlow Grass
DRACUN	5	Draba cuneifolia	Nt A-FORB	Wedgeleaf Draba
DRAREP	2	Draba reptans	Nt A-FORB	Common Whitlow Grass
DRAVER	*	DRABA VERNA	Ad A-FORB	Vernal Whitlow Grass
DRAPAR	*	DRACOCEPHALUM PARVIFLORUM	Ad A-FORB	American Dragonhead
DRYARG	10	Drymocallis arguta	Nt P-FORB	Prairie Cinquefoil
DRYCAR	10	Dryopteris carthusiana	Nt FERN	Spinulose Shield Fern
DRYCEL	10	Dryopteris celsa	Nt FERN	Log Fern

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
DRYCRI	10	Dryopteris cristata	Nt FERN	Crested Shield Fern
DRYGOL	9	Dryopteris goldiana	Nt FERN	Goldie Fern
DRYINT	10	Dryopteris intermedia	Nt FERN	Intermediate Shield Fern
DRYMAR	7	Dryopteris marginalis	Nt FERN	Marginal Shield Fern
DUCIND	*	DUCHESNEA INDICA	Ad P-FORB	Indian Strawberry
DULARU	9	Dulichium arundinaceum	Nt P-SEDGE	Pond Sedge
DYSPAP	1	Dyssodia papposa	Nt A-FORB	Fetid Marigold
ECHANG	8	Echinacea angustifolia◀	Nt P-FORB	Narrow-Leafed Coneflower
ECHPAL	7	Echinacea pallida	Nt P-FORB	Pale Purple Coneflower
ECHPAR	9	Echinacea paradoxa	Nt P-FORB	Yellow Coneflower
ECHPUR	5	Echinacea purpurea	Nt P-FORB	Purple Coneflower
ECHSIM	7	Echinacea simulata	Nt P-FORB	Glade Purple Coneflower
ECHCOL	*	ECHINOCHLOA COLONUM	Ad A-GRASS	Jungle Rice
ECHCRG†	*	ECHINOCHLOA CRUSGALLI	Ad A-GRASS	Barnyard Grass
ECHCRP†	*	ECHINOCHLOA CRUS-PAVONIS var. MACERA	Ad A-GRASS	Gulf Cockspur Grass
ECHMUR	2	Echinochloa muricata	Nt A-GRASS	Cockspur Grass
ECHWAL	7	Echinochloa walteri	Nt A-GRASS	Marsh Cockspur Grass
ECHLOB	5	Echinocystis lobata	Nt A-FORB	Wild Cucumber
ECHBER	8	Echinodorus berteroi	Nt A-FORB	Upright Burhead
ECHCOR	8	Echinodorus cordifolius	Nt P-FORB	Creeping Burhead
ECHTEN	9	Echinodorus tenellus	Nt A-FORB	Dwarf Burhead
ECHVUL	*	ECHIUM VULGARE	Ad B-FORB	Blueweed
ECLPRO	3	Eclipta prostrata	Nt A-FORB	Yerba De Tajo
EGEDEN	*	EGERIA DENSA	Ad P-FORB	Brazilian Waterweed
EICCRA	*	EICHHORNIA CRASSIPES	Ad P-FORB	Water Hyacinth
ELAANG	*	ELAEAGNUS ANGUSTIFOLIA	Ad SHRUB	Russian Olive
ELAUMB	*	ELAEAGNUS UMBELLATA	Ad SHRUB	Autumn Olive
ELATRI	10	Elatine triandra	Nt A-FORB	Waterwort
ELEACI	5	Eleocharis acicularis	Nt P-SEDGE	Needle Spike Rush
ELEATR	10	Eleocharis atropurpurea	Nt A-SEDGE	Purple Spike Rush
ELECOA†	6	Eleocharis compressa var. acutisquamata◀	Nt P-SEDGE	Flat-Stemmed Spike Rush
ELECOC†	5	Eleocharis compressa var. compressa◀	Nt P-SEDGE	Flat-Stemmed Spike Rush
ELEELL	4	Eleocharis elliptica	Nt P-SEDGE	Elliptic Spike Rush
ELEENG	5	Eleocharis engelmannii◀	Nt A-SEDGE	Engelmann's Spike Rush
ELEEQU	10	Eleocharis equisetoides	Nt P-SEDGE	Knotted Spike Rush
ELEERY	5	Eleocharis erythropoda	Nt P-SEDGE	Bald Spike Rush
ELELAN	6	Eleocharis lanceolata	Nt A-SEDGE	Daggerleaf Spike-Rush
ELEMAC	7	Eleocharis macrostachya◀	Nt P-SEDGE	Pale Spike-Rush
ELEOBT	2	Eleocharis obtusa◀	Nt A-SEDGE	Blunt Spike Rush

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ELEOVA	2	Eleocharis ovata◀	Nt A-SEDGE	Oval Spike Rush
ELEPAL	5	Eleocharis palustris	Nt P-SEDGE	Marsh Spike Rush
ELEPAR	7	Eleocharis parvula	Nt P-SEDGE	Small Spike-Rush
ELEQUA	5	Eleocharis quadrangulata	Nt P-SEDGE	Angled Spike Rush
ELETEN	6	Eleocharis tenuis var. atrata◀	Nt P-SEDGE	Wiry Spike Rush
ELEVER	4	Eleocharis verrucosa	Nt P-SEDGE	Slender Spike Rush
ELEWOL	9	Eleocharis wolfii	Nt P-SEDGE	Wolf's Spike Rush
ELEXYR	7	Eleocharis xyridiformis◀	Nt P-SEDGE	Big Flat Spike Rush
ELECAR	3	Elephantopus carolinianus	Nt P-FORB	Elephant's Foot
ELEIND	*	ELEUSINE INDICA	Ad A-GRASS	Indian Goose Grass
ELETRI	*	ELEUSINE TRISTACHYA	Ad P-GRASS	Threespike Goose Grass
ELLNYC	1	Ellisia nyctelea	Nt A-FORB	Aunt Lucy
ELOCAN	10	Elodea canadensis	Nt P-FORB	Common Waterweed
ELONUT	7	Elodea nuttallii	Nt P-FORB	Slender Waterweed
ELYCAN	5	Elymus canadensis	Nt P-GRASS	Canada Wild Rye
ELYCHU	10	Elymus churchii◀	Nt P-GRASS	Church's Wild Rye
ELYCUR	3	Elymus curvatus◀	Nt P-GRASS	Awnless Wild Rye
ELYELO	*	ELYMUS ELONGATUS subsp. PONTICUS	Ad P-GRASS	Tall Wheat Grass
ELYGLR†	4	Elymus glabriflorus◀	Nt P-GRASS	Southeastern Wild Rye
ELYGLU†	10	Elymus glaucus	Nt P-GRASS	Blue Wild Rye
ELYHYS	4	Elymus hystrix	Nt P-GRASS	Bottlebrush Grass
ELYJEJ	7	Elymus jejunus◀	Nt P-GRASS	Virginia Wild Rye
ELYLON	*	ELYMUS LONGIFOLIUS	Ad P-GRASS	Squirreltail
ELYMAC	6	Elymus macgregorii◀	Nt P-GRASS	Early Wild Rye
ELYREP	*	ELYMUS REPENS	Ad P-GRASS	Quack Grass
ELYRIP	7	Elymus riparius	Nt P-GRASS	Riverbank Wild Rye
ELYTRA	*	ELYMUS TRACHYCAULUS	Ad P-GRASS	Slender Wheat Grass
ELYVIL	4	Elymus villosus	Nt P-GRASS	Silky Wild Rye
ELYVIR	5	Elymus virginicus	Nt P-GRASS	Virginia Wild Rye
ENGPER	*	ENGELMANNIA PERISTENIA	Ad P-FORB	Engelmann's Daisy
EPIVIR	10	Epifagus virginiana	Nt P-FORB	Beech Drops
EPICIL	*	EPILOBIUM CILIATUM	Ad P-FORB	Fringed Willow Herb
EPICOL	6	Epilobium coloratum	Nt P-FORB	Cinnanmon Willow Herb
EPILEP	10	Epilobium leptophyllum	Nt P-FORB	Fen Willow Herb
EPIHEL	*	EPIPACTIS HELLEBORINE	Ad P-FORB	Hellerborine
EQUFER	3	Equisetum × ferrissii	Nt FERN	Ferriss' Horsetail
EQUNEL	10	Equisetum × nelsonii	Nt FERN	Fen Horsetail
EQUARV	1	Equisetum arvense	Nt FERN	Horsetail
EQUHYE	3	Equisetum hyemale	Nt FERN	Scouring Rush

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
EQULAE	4	Equisetum laevigatum	Nt FERN	Smooth Scouring Rush
ERABAR	*	ERAGROSTIS BARRELIERI	Ad A-GRASS	Mediterranean Love Grass
ERACAP	3	Eragrostis capillaris	Nt A-GRASS	Lace Grass
ERACIL	*	ERAGROSTIS CILIANENSIS	Ad A-GRASS	Stink Grass
ERACUT†	*	ERAGROSTIS CURTIPEDICELLATA	Ad P-GRASS	Gummy Love Grass
ERACUV†	*	ERAGROSTIS CURVULA	Ad P-GRASS	Weeping Love Grass
ERAELL	*	ERAGROSTIS ELLIOTTII	Ad P-GRASS	Elliott's Love Grass
ERAFRA	3	Eragrostis frankii	Nt A-GRASS	Sandbar Love Grass
ERAGLO	4	Eragrostis glomerata	Nt A-GRASS	Pond Love Grass
ERAHIR	4	Eragrostis hirsuta	Nt P-GRASS	Bigtop Love Grass
ERAHYP	4	Eragrostis hypnoides	Nt A-GRASS	Creeping Love Grass
ERAINT	5	Eragrostis intermedia	Nt P-GRASS	Plains Love Grass
ERAMIN	*	ERAGROSTIS MINOR	Ad A-GRASS	Little Love Grass
ERAPEM†	*	ERAGROSTIS PECTINACEA var. MISERRIMA	Ad A-GRASS	Carolina Love Grass
ERAPEP†	0	Eragrostis pectinacea var. pectinacea	Nt A-GRASS	Small Love Grass
ERAPIL	*	ERAGROSTIS PILOSA	Ad A-GRASS	India Love Grass
ERAREP	10	Eragrostis reptans	Nt A-GRASS	Pony Grass
ERASEC	*	ERAGROSTIS SECUNDIFLORA subsp. OXYLEPIS	Ad P-GRASS	Red Love Grass
ERASPE	3	Eragrostis spectabilis	Nt P-GRASS	Purple Love Grass
ERATRI	4	Eragrostis trichodes	Nt P-GRASS	Tall Love Grass
ERAHYE	*	ERANTHUS HYEMALIS	Ad P-FORB	Winter Aconite
EREHIE	1	Erechtites hieracifolius	Nt A-FORB	Fireweed
ERIALO	8	Erianthus alopecuroides	Nt P-GRASS	Silver Plumegrass
ERIGIG	*	ERIANTHUS GIGANTEUS	Ad P-GRASS	Sugarcane Plumegrass
ERIRAV	*	ERIANTHUS RAVENNAE	Ad P-GRASS	Plumegrass
ERISTT	10	Erianthus strictus	Nt P-GRASS	Narrow Plumegrass
ERIBUL	6	Erigenia bulbosa	Nt P-FORB	Harbinger Of Spring
ERIGAN†	1	Erigeron annuus	Nt A-FORB	Annual Fleabane
ERIPHI	3	Erigeron philadelphicus	Nt B-FORB	Marsh Fleabane
ERIPUL	6	Erigeron pulchellus	Nt B-FORB	Robin's Plantain
ERISTG†	3	Erigeron strigosus	Nt A-FORB	Daisy Fleabane
ERITEN	4	Erigeron tenuis	Nt P-FORB	Slender Rough Fleabane
ERIACU	*	ERIOCHLOA ACUMINATA	Ad A-GRASS	Cup Grass
ERICON	*	ERIOCHLOA CONTRACTA	Ad A-GRASS	Prairie Cup Grass
ERIVIL	*	ERIOCHLOA VILLOSA	Ad A-GRASS	Wooly Cup Grass
ERIOAN	*	ERIOGONUM ANNUUM	Ad A-FORB	Annual Buckwheat
ERILON	10	Eriogonum longifolium	Nt P-FORB	Umbrella Plant
EROCIC	*	ERODIUM CICUTARIUM	Ad A-FORB	Storksbill

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
EROTEX	*	ERODIUM TEXANUM	Ad A-FORB	Large-Flowered Storkbill
ERUVES	*	ERUCA VESICARIA subsp. SATIVA	Ad A-FORB	Garden Rocket
ERUGAL	*	ERUCASTRUM GALLICUM	Ad A-FORB	Dog Mustard
ERYLEA	*	ERYNGIUM LEAVENWORTHII	Ad A-FORB	Leavenworth Eryngo
ERYPRO	5	Eryngium prostratum	Nt P-FORB	Creeping Coyote Thistle
ERYYUC	8	Eryngium yuccifolium	Nt P-FORB	Rattlesnake Master
ERYCAP	8	Erysimum capitatum	Nt B-FORB	Western Wallflower
ERYCHE	*	ERYSIMUM CHEIRANTHOIDES	Ad A-FORB	Wormseed Mustard
ERYINC	*	ERYSIMUM INCONSPICUUM	Ad P-FORB	Small Wormseed Mustard
ERYREP	*	ERYSIMUM REPANDUM	Ad A-FORB	Treacle Mustard
ERYALB	5	Erythronium albidum	Nt P-FORB	White Trout Lily
ERYAME	8	Erythronium americanum	Nt P-FORB	Yellow Trout Lily
ERYMES	7	Erythronium mesochoreum	Nt P-FORB	Prairie Trout Lily
ERYROS	8	Erythronium rostratum	Nt P-FORB	Southern Yellow Trout Lily
ESCCAL	*	ESCHSCHOLTZIA CALIFORNICA	Ad P-FORB	California Poppy
EUOALA	*	EUONYMUS ALATUS	Ad SHRUB	Winged Wahoo
EUOAME	10	Euonymus americanus	Nt SHRUB	Strawberry Bush
EUOATR	5	Euonymus atropurpureus	Nt SHRUB	Wahoo
EUOEUR	*	EUONYMUS EUROPAEUS	Ad SHRUB	European Spindletree
EUOHED	*	EUONYMUS HEDERACEUS	Ad SHRUB	Wintercreeper
EUOOBO	9	Euonymus obovatus	Nt SHRUB	Running Strawberry Bush
EUPALB	7	Eupatorium album ◄	Nt P-FORB	White Throughwort
EUPALT	3	Eupatorium altissimum	Nt P-FORB	Tall Boneset
EUPCAP	*	EUPATORIUM CAPILLIFOLIUM	Ad A-FORB	Yankeeweed
EUPFIS	8	Eupatorium fistulosum	Nt P-FORB	Hollow Joe Pye Weed
EUPHYS	5	Eupatorium hyssopifolium var. calcaratum	Nt P-FORB	Hyssop-Leaved Thoroughwort
EUPMAC	10	Eupatorium maculatum	Nt P-FORB	Spotted Joe Pye Weed
EUPPER	3	Eupatorium perfoliatum	Nt P-FORB	Common Boneset
EUPPUR	6	Eupatorium purpureum	Nt P-FORB	Purple Joe Pye Weed
EUPROT	3	Eupatorium rotundifolium	Nt P-FORB	Round-Leaved Boneset
EUPSEM	8	Eupatorium semiserratum	Nt P-FORB	Small-Flowered Thoroughwort
EUPSER	1	Eupatorium serotinum	Nt P-FORB	Late Boneset
EUPSES	7	Eupatorium sessilifolium	Nt P-FORB	Upland Boneset
EUPTOR	3	Eupatorium torreyanum ◄	Nt P-FORB	Torrey's Boneset
EPHCOM†	6	Euphorbia commutata	Nt B-FORB	Tinted Spurge
EPHCOR†	3	Euphorbia corollata	Nt P-FORB	Flowering Spurge
EPHCYA†	4	Euphorbia cyathophora	Nt A-FORB	Painted Spurge
EPHCYP†	*	EUPHORBIA CYPARISSIAS	Ad P-FORB	Cypress Spurge

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
EPHDAV†	1	Euphorbia davidii	Nt A-FORB	Narrow-Lesved Toothed Spurge
EPHDEN†	0	Euphorbia dentata	Nt A-FORB	Toothed Spurge
EPHESU†	*	EUPHORBIA ESULA	Ad P-FORB	Leafy Spurge
EPHGEY†	10	Euphorbia geyeri	Nt A-FORB	Geyer's Spurge
EPHGLY†	6	Euphorbia glyptosperma	Nt A-FORB	Ridge-Seeded Spurge
EPHHUM†	3	Euphorbia humistrata	Nt A-FORB	Spreading Spurge
EPHMAC†	0	Euphorbia maculata	Nt A-FORB	Creeping Spurge
EPHMAR†	3	Euphorbia marginata	Nt A-FORB	Snow-On-The-Mountain
EPHMIS†	8	Euphorbia missurica	Nt A-FORB	Missouri Spurge
EPHNUT†	0	Euphorbia nutans	Nt A-FORB	Nodding Spurge
EPHOBT†	3	Euphorbia obtusata	Nt A-FORB	Blunt-Leaved Spurge
EUPOPT	*	EUPHORBIA OPTHALMICA	Ad A-FORB	Florida Hammock Sandmat
EUPOUA	6	Euphorbia ouachitana◀	Nt A-FORB	Ouachita Spurge
EPHPRO†	*	EUPHORBIA PROSTRATA	Ad A-FORB	Groundfig Spurge
EPHSEE†	4	Euphorbia serpens	Nt A-FORB	Round-Leaved Spurge
EPHSEY†	*	EUPHORBIA SERPYLLIFOLIA◀	Ad A-FORB	Thyme-Leaved Spurge
EPHSPA†	5	Euphorbia spathulata	Nt A-FORB	Prairie Spurge
EPHSTI†	*	EUPHORBIA STICTOSPORA	Ad A-FORB	Mat Spurge
EURFUR	10	Eurybia furcata	Nt P-FORB	Forked Aster
EURHEM	9	Eurybia hemispherica	Nt P-FORB	Southern Swamp Aster
EURMAC	10	Eurybia macrophylla	Nt P-FORB	Big-Leaved Aster
EUTGRA	3	Euthamia graminifolia	Nt P-FORB	Hairy Grass-Leaved Goldenrod
EUTGYM	4	Euthamia gymnospermoides	Nt P-FORB	Viscid Grass-Leaved Goldenrod
EUTLEP	8	Euthamia leptocephala	Nt P-FORB	Western Bushy Goldenrod
EVOALS	*	EVOLVULUS ALSINOIDES	Ad P-FORB	Dwarf Morning Glory
EVONUT	8	Evolvulus nuttallianus	Nt P-FORB	Shaggy Evolvulus
EXORAC	*	EXOCHORDA RACEMOSA	Ad SHRUB	Common Pearlbush
FAGESC	*	FAGOPYRUM ESCULENTUM	Ad A-FORB	Buckwheat
FAGGRA	8	Fagus grandifolia	Nt TREE	Beech
FALVUL	*	FALCARIA VULGARIS	Ad P-FORB	Sickleweed
FALCON	*	FALLOPIA CONVOLVULUS	Ad A-FORB	Black Bindweed
FALDUM	*	FALLOPIA DUMETORUM	Ad P-FORB	False Buckwheat Weed
FALJAP	*	FALLOPIA JAPONICA	Ad P-FORB	Japanese Knotweed
FALSCA	3	Fallopia scandens	Nt P-FORB	Climbing False Buckwheat
FATVIL	*	FATOUA VILLOSA	Ad A-FORB	Hairy Crabweed
FESARU	*	FESTUCA ARUNDINACEA	Ad P-GRASS	Tall Fescue
FESOVI	*	FESTUCA OVINA	Ad P-GRASS	Sheep Fescue
FESPAR	6	Festuca paradoxa	Nt P-GRASS	Cluster Fescue

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
FESPRA	*	FESTUCA PRATENSIS	Ad P-GRASS	Meadow Fescue
FESRUB	*	FESTUCA RUBRA	Ad P-GRASS	Red Fescue
FESSOR	*	FESTUCA SORORIA	Ad P-GRASS	Ravine Fescue
FESSUB	4	Festuca subverticillata	Nt P-GRASS	Nodding Fescue
FESTRA	*	FESTUCA TRACHYPHYLLA	Ad P-GRASS	Hard Fescue
FILRUB	10	Filipendula rubra	Nt P-FORB	Queen of the Prairie
FIMANN	5	Fimbristylis annua	Nt A-SEDGE	Tall Fimbry
FIMAUT	5	Fimbristylis autumnalis	Nt A-SEDGE	Autumn Sedge
FIMLIT	*	FIMBRISTYLIS LITTORALIS	Ad A-SEDGE	Grassy-Like Fimbry
FIMPUB	7	Fimbristylis puberula	Nt P-SEDGE	Glade Fimbry
FIMVAH	4	Fimbristylis vahlii	Nt A-SEDGE	Vahl's Fimbry
FLACAM	*	FLAVERIA CAMPESTRIS	Ad A-FORB	Plains Flaveria
FLEINC	9	Fleischmannia incarnata	Nt P-FORB	Pink Thoroughwort
FLOPRO	10	Floerkea proserpinacoides	Nt A-FORB	False Mermaid
FOEVUL	*	FOENICULUM VULGARE	Ad P-FORB	Fennel
FONPHI	*	FONTANESIA PHILLYREOIDES subsp. FORTUNEI	Ad SHRUB	Persian Lilac
FORACU	6	Forestiera acuminata	Nt TREE	Swamp Privet
FORSUS	*	FORSYTHIA SUSPENSA	Ad SHRUB	Weeping Forsythia
FRAANA	*	FRAGARIA × ANANASSA	Ad P-FORB	Garden Strawberry
FRAVES	10	Fragaria vesca var. americana	Nt P-FORB	Hillside Strawberry
FRAVIR	3	Fragaria virginiana	Nt P-FORB	Wild Strawberry
FRACAR	7	Frasera caroliniensis	Nt P-FORB	American Columbo
FRAAME	4	Fraxinus americana	Nt TREE	White Ash
FRABIL	5	Fraxinus biltmoreana	Nt TREE	Biltmore Ash
FRAPEP†	5	Fraxinus pennsylvanica var. pennsylvanica◀	Nt TREE	Red Ash
FRAPES†	2	Fraxinus pennsylvanica var. subintegerrima◀	Nt TREE	Green Ash
FRAPRO	8	Fraxinus profunda	Nt TREE	Pumpkin Ash
FRAQUA	7	Fraxinus quadrangulata	Nt TREE	Blue Ash
FRASMA	3	Fraxinus smallii◀	Nt TREE	Sullivan's Ash
FROFLO	4	Froelichia floridana var. campestris	Nt A-FORB	Large Cottonweed
FROGRA	3	Froelichia gracilis	Nt A-FORB	Small Cottonweed
FUISIA†	10	Fuirena simplex var. aristatula	Nt A-SEDGE	Plains Umbrella Grass
FUISIS†	8	Fuirena simplex var. simplex	Nt P-SEDGE	Umbrella Grass
FUMOFF	*	FUMARIA OFFICINALIS	Ad A-FORB	Fumitory
GAIAES	10	Gaillardia aestivalis var. flavovirens	Nt P-FORB	Yellow Blanket Flower
GAIPUL	*	GAILLARDIA PULCHELLA	Ad A-FORB	Blanket Flower
GALREG	6	Galactia regularis	Nt P-FORB	Milk Pea
GALNIV	*	GALANTHUS NIVALIS	Ad P-FORB	Snowdrop

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
GALSPE	7	Galearis spectabilis	Nt P-FORB	Showy Orchis
GALTET	*	GALEOPSIS TETRAHIT	Ad A-FORB	Common Hemp Nettle
GALPAR	*	GALINSOGA PARVIFLORA	Ad A-FORB	Smooth Peruvian Daisy
GALQUA	*	GALINSOGA QUADRIRADIATA	Ad A-FORB	Peruvian Daisy
GALANG	*	GALIUM ANGLICUM	Ad A-FORB	Lamarck's Bedstraw
GALAPA	0	Galium aparine	Nt A-FORB	Annual Bedstraw
GALARK	6	Galium arkansanum	Nt P-FORB	Arkansas Bedstraw
GALASP	10	Galium asprellum	Nt P-FORB	Rough Bedstraw
GALBOR	10	Galium boreale	Nt P-FORB	Northern Bedstraw
GALCIR	4	Galium circaezans	Nt P-FORB	Licorice Bedstraw
GALCON	4	Galium concinnum	Nt P-FORB	Shining Bedstraw
GALDIV	*	GALIUM DIVARICATUM	Ad A-FORB	Wall Bedstraw
GALOBT	5	Galium obtusum	Nt P-FORB	Wild Madder
GALPED	*	GALIUM PEDEMONTANUM	Ad A-FORB	Piedmont Bedstraw
GALPIL	6	Galium pilosum	Nt P-FORB	Hairy Bedstraw
GALTIN	6	Galium tinctorium	Nt P-FORB	Stiff Bedstraw
GALTRI	4	Galium triflorum	Nt P-FORB	Sweet-Scented Bedstraw
GALVER	*	GALIUM VERUM	Ad P-FORB	Yellow Bedstraw
GALVIR	4	Galium virgatum	Nt A-FORB	Dwarf Bedstraw
GAMARG	2	Gamochaeta argyrinea	Nt A-FORB	Southern Cudweed
GAMPEN	*	GAMOCHAETA PENSYLVANICA	Ad A-FORB	Pennsylvania Cudweed
GAMPUR	3	Gamochaeta purpurea	Nt A-FORB	Early Cudweed
GAUCOC	4	Gaura coccinea	Nt P-FORB	Scarlet Gaura
GAULON	1	Gaura longiflora	Nt B-FORB	Biennial Gaura
GAUPAR	2	Gaura parviflora	Nt B-FORB	Small-Flowered Gaura
GAUSIN	*	GAURA SINUATA	Ad P-FORB	Wavy-Leaved Gaura
GAYBAC	10	Gaylussacia baccata	Nt SHRUB	Huckleberry
GENALB	8	Gentiana alba	Nt P-FORB	Yellowish Gentian
GENANA†	10	Gentiana andrewsii var. andrewsii	Nt P-FORB	Closed Gentian
GENANK†	9	Gentiana andrewsii var. dakotica	Nt P-FORB	Closed Gentian
GENPUB	9	Gentiana puberulenta	Nt P-FORB	Downy Gentian
GENQUI	10	Gentianella quinquefolia subsp. occidentalis	Nt A-FORB	Stiff Gentian
GEOMIN	10	Geocarpon minimum	Nt A-FORB	Geocarpon
GERCAR	0	Geranium carolinianum	Nt A-FORB	Carolina Cranesbill
GERCOL	*	GERANIUM COLUMBINUM	Ad A-FORB	Longstalk Cranesbill
GERDIS	*	GERANIUM DISSECTUM	Ad A-FORB	Cut-Leaved Cranesbill
GERMAC	5	Geranium maculatum	Nt P-FORB	Wild Geranium
GERMOL	*	GERANIUM MOLLE	Ad A-FORB	Dove's-Foot Cranesbill
GERPUS	*	GERANIUM PUSILLUM	Ad A-FORB	Small Geranium

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
GEUCAN	2	Geum canadense	Nt P-FORB	White Avens
GEUFRA	10	Geum fragarioides	Nt P-FORB	Barren Strawberry
GEULAC	6	Geum laciniatum	Nt P-FORB	Rough Avens
GEUTRI	10	Geum triflorum	Nt P-FORB	Prairie Smoke
GEUVER	3	Geum vernum	Nt P-FORB	Spring Avens
GEUVIR	9	Geum virginianum	Nt P-FORB	Pale Avens
GILSTI	5	Gillenia stipulata	Nt P-FORB	American Ipecac
GILTRI	10	Gillenia trifoliata	Nt P-FORB	Bowman's Root
GLACOM	*	GLADIOLUS COMMUNIS	Ad P-FORB	Garden Gladiolus
GLABIP	0	Glandularia bipinnatifida	Nt P-FORB	Dakota Verbena
GLACAN	5	Glandularia canadensis	Nt P-FORB	Rose Vervain
GLEHED	*	GLECHOMA HEDERACEA	Ad P-FORB	Creeping Charlie
GLEAQU	10	Gleditsia aquatica	Nt TREE	Water Locust
GLETRI	2	Gleditsia triacanthos	Nt TREE	Honey Locust
GLILOT	*	GLINUS LOTOIDES	Ad A-FORB	Glinus
GLYACU	10	Glyceria acutiflora	Nt P-GRASS	Sharp-Scaled Manna Grass
GLYSEA††	9	Glyceria septentrionalis var. arkansana	Nt P-GRASS	Arkansas Manna Grass
GLYSES	8	Glyceria septentrionalis var. septentrionalis	Nt P-GRASS	Floating Mannagrass
GLYSTR	4	Glyceria striata	Nt P-GRASS	Fowl Manna Grass
GLYMAX	*	GLYCINE MAX	Ad A-FORB	Soy Bean
GLYLEP	4	Glycyrrhiza lepidota	Nt P-FORB	Wild Licorice
GONSUB	7	Gonolobus suberosus	Nt P-FORB	Large-Leaved Angle-Pod
GOOPUB	10	Goodyera pubescens	Nt P-FORB	Rattlesnake Plantain
GOSHIR	*	GOSSYPIUM HIRSUTUM	Ad A-FORB	Cotton
GRANEG	4	Gratiola neglecta	Nt A-FORB	Clammy Hedge Hyssop
GRAVIR	8	Gratiola virginiana	Nt B-FORB	Round-Fruited Hedge Hyssop
GRAVIS	10	Gratiola viscidula	Nt P-FORB	Hedge Hyssop
GRICIL	*	GRINDELIA CILIATA	Ad A-FORB	Goldenweed
GRILAN	3	Grindelia lanceolata	Nt P-FORB	Spiny-Toothed Gumweed
GRISQU	*	GRINDELIA SQUARROSA	Ad B-FORB	Gum Plant
GUIABY	*	GUIZOTIA ABYSSINICA	Ad A-FORB	Niger Thistle
GUTTEX	*	GUTIERREZIA TEXANA	Ad A-FORB	Texas Snakeweed
GYMDIO	6	Gymnocladus dioica	Nt TREE	Kentucky Coffee Tree
GYMAMB	8	Gymnopogon ambiguus	Nt P-GRASS	Beard Grass
HACVIR	3	Hackelia virginiana	Nt B-FORB	Stickseed
HALDIP	*	HALESIA DIPTERA	Ad SHRUB	Two-Wing Silverbell
HAMVER	7	Hamamelis vernalis	Nt SHRUB	Vernal Witch Hazel
HAMVIR	9	Hamamelis virginiana	Nt TREE	Witch Hazel
HASSUA	9	Hasteola suaveolens	Nt P-FORB	Sweet Indian Plantain

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
HEDHIS	3	Hedeoma hispida	Nt A-FORB	Rough Pennyroyal
HEDPUL	4	Hedeoma pulegioides	Nt A-FORB	American Pennyroyal
HEDHEL	*	HEDERA HELIX	Ad W-VINE	English Ivy
HELAMA	*	HELENIUM AMARUM	Ad A-FORB	Bitterweed
HELAUT	5	Helenium autumnale	Nt P-FORB	Sneezeweed
HELFLE	3	Helenium flexuosum	Nt P-FORB	Purple-Head Sneezeweed
HELVIR	8	Helenium virginicum	Nt P-FORB	Virginia Sneezeweed
HELBIC	6	Helianthemum bicknellii	Nt P-FORB	Hoary Rockrose
HELCAN	10	Helianthemum canadense	Nt P-FORB	Canada Rockrose
HELLAE	6	Helianthus × laetiflorus	Nt P-FORB	Prairie Sunflower
HELANG	8	Helianthus angustifolius	Nt P-FORB	Swamp Sunflower
HELANN	0	Helianthus annuus	Nt A-FORB	Garden Sunflower
HELDEC	9	Helianthus decapetalus	Nt P-FORB	Pale Sunflower
HELDIV	6	Helianthus divaricatus	Nt P-FORB	Woodland Sunflower
HELGRO	4	Helianthus grosseserratus	Nt P-FORB	Sawtooth Sunflower
HELHIR	4	Helianthus hirsutus	Nt P-FORB	Oblong Sunflower
HELMAX	5	Helianthus maximilianii	Nt P-FORB	Maximillian Sunflower
HELMIC	8	Helianthus microcephalus	Nt P-FORB	Small Wood Sunflower
HELMOL	6	Helianthus mollis	Nt P-FORB	Downy Sunflower
HELOCC	5	Helianthus occidentalis	Nt P-FORB	Western Sunflower
HELPAP†	5	Helianthus pauciflorus subsp. pauciflorus	Nt P-FORB	Showy Sunflower
HELPAS†	*	HELIANTHUS PAUCIFLORUS subsp. SUBRHOMBOIDEUS	Ad P-FORB	Stiff Sunflower
HELPET	*	HELIANTHUS PETIOLARIS◄	Ad A-FORB	Kansas Sunflower
HELSAL	8	Helianthus salicifolius	Nt P-FORB	Willow-Leaved Sunflower
HELSIL	7	Helianthus silphioides	Nt P-FORB	Ozark Sunflower
HELSTR	7	Helianthus strumosus◄	Nt P-FORB	Pale-Leaved Sunflower
HELTUB	3	Helianthus tuberosus	Nt P-FORB	Jerusalem Artichoke
HELHEH†	5	Heliopsis helianthoides var. helianthoides◄	Nt P-FORB	False Sunflower
HELHES†	5	Heliopsis helianthoides var. scabra◄	Nt P-FORB	Woodland False Sunflower
HELAMP	*	HELIOTROPIUM AMPLEXICAULE	Ad P-FORB	Clasping Heliotrope
HELCUR	2	Heliotropium curassavicum	Nt A-FORB	Seaside Heliotrope
HELIND	*	HELIOTROPIUM INDICUM	Ad A-FORB	Indian Heliotrope
HELPRO	*	HELIOTROPIUM PROCUMBENS◄	Ad A-FORB	Fourspike Heliotrope
HELTEN	8	Heliotropium tenellum	Nt A-FORB	Glade Heliotrope
HELECH	*	HELMINOTHECA ECHIOIDES	Ad A-FORB	Ox-Tongue
HEMFUL	*	HEMEROCALLIS FULVA	Ad P-FORB	Orange Day Lily
HERSPH	6	Heracleum sphondylium subsp. montanum	Nt P-FORB	Cow Parsnip
HESMAT	*	HESPERIS MATRONALIS	Ad P-FORB	Dame's Rocket
HETDUB	7	Heteranthera dubia	Nt P-FORB	Water Star-Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
HETLIM	5	Heteranthera limosa	Nt A-FORB	Mud Plantain
HETMUL	5	Heteranthera multiflora	Nt A-FORB	Bouquet Mud Plantain
HETREN	10	Heteranthera reniformis	Nt A-FORB	Kidney-Leaf Mud Plantain
HETROT	5	Heteranthera rotundifolia	Nt A-FORB	Roundleaf Mud Plantain
HETCAM	1	Heterotheca camporum	Nt P-FORB	Narrow-Leaved Golden Aster
HETCAN	10	Heterotheca canescens	Nt P-FORB	Hairy Golden Aster
HETSUB	2	Heterotheca subaxillaris	Nt A-FORB	Broad-Leaved Golden Aster
HEUAME	7	Heuchera americana	Nt P-FORB	Alum Root
HEUPAA†	10	Heuchera parviflora var. parviflora	Nt P-FORB	Small-Flowered Alum Root
HEUPAU†	10	Heuchera parviflora var. puberula	Nt P-FORB	Small-Flowered Alum Root
HEURIC	6	Heuchera richardsonii	Nt P-FORB	Prairie Alum Root
HEUVIL	10	Heuchera villosa	Nt P-FORB	Hairy Alum Root
HEXSPI	8	Hexalectris spicata	Nt P-FORB	Crested Coral Root
HIBLAE	4	Hibiscus laevis	Nt P-FORB	Halberd-Leaved Rose Mallow
HIBLAS	5	Hibiscus lasiocarpos	Nt P-FORB	Rose Mallow
HIBSYR	*	HIBISCUS SYRIACUS	Ad SHRUB	Rose Of Sharon
HIBTRI	*	HIBISCUS TRIONUM	Ad A-FORB	Flower-Of-An-Hour
HIECAE	*	HIERACIUM CAESPITOSUM	Ad P-FORB	Yellow King Devil
HIEGRO	4	Hieracium gronovii	Nt P-FORB	Hairy Hawkweed
HIELON	6	Hieracium longipilum	Nt P-FORB	Long-Bearded Hawkweed
HIESCA	7	Hieracium scabrum	Nt P-FORB	Rough Hawkweed
HOLLAN	*	HOLCUS LANATUS	Ad P-GRASS	Velvet Grass
HOLUMB	*	HOLOSTEUM UMBELLATUM	Ad A-FORB	Jagged Chickweed
HORJUB	0	Hordeum jubatum	Nt P-GRASS	Squirrel-Tail Grass
HORPUS	0	Hordeum pusillum	Nt A-GRASS	Little Barley
HORVUL	*	HORDEUM VULGARE	Ad A-GRASS	Barley
HOTINF	10	Hottonia inflata	Nt A-FORB	Water Violet
HOUCAE	6	Houstonia caerulea	Nt A-FORB	Bluets
HOULOL†	5	Houstonia longifolia var. longifolia◀	Nt P-FORB	Long-Leaved Bluets
HOULOT†	5	Houstonia longifolia var. tenuifolia◀	Nt P-FORB	Long-Leaved Bluets
HOUMIC	4	Houstonia micrantha	Nt A-FORB	Southern Bluets
HOUNIG	5	Houstonia nigricans	Nt P-FORB	Narrow-Leaved Bluets
HOUPUR	6	Houstonia purpurea	Nt P-FORB	Broad-Leaved Bluets
HOUPUS	3	Houstonia pusilla	Nt A-FORB	Least Bluets
HOUROS	10	Houstonia rosea	Nt A-FORB	Rose Bluets
HUMJAP	*	HUMULUS JAPONICUS	Ad A-FORB	Japanese Hop
HUMLUL†	*	Humulus lupulus var. lupulus	Ad P-FORB	European Hop
HUMLUN†	2	Humulus lupulus var. neomexicanus	Nt P-FORB	Western Hop

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
HUMLUB†	2	Humulus lupulus var. pubescens	Nt P-FORB	American Hop
HUPLUC	10	Huperzia lucidula	Nt FERN	Shining Clubmoss
HUPPOR	10	Huperzia porophila	Nt FERN	Fir Clubmoss
HYDARB	7	Hydrangea arborescens	Nt SHRUB	Wild Hydrangea
HYDSCA†	6	Hydrastis canadensis	Nt P-FORB	Golden Seal
HYDIVE†	*	HYDRILLA VERTICILLATA	Ad P-FORB	Water-Thyme
HYDRAN	0	Hydrocotyle ranunculoides	Nt P-FORB	Floating Water Pennywort
HYDOVE†	10	Hydrocotyle verticillata	Nt P-FORB	Whorled Water Pennywort
HYDOVA	10	Hydrolea ovata	Nt P-FORB	Blue Waterleaf
HYDUNI	6	Hydrolea uniflora	Nt P-FORB	One-Flower False-Fiddle-Leaf
HYDAPP	6	Hydrophyllum appendiculatum	Nt P-FORB	Great Waterleaf
HYDPCA†	7	Hydrophyllum canadense	Nt P-FORB	Canada Waterleaf
HYDVIR	4	Hydrophyllum virginianum	Nt P-FORB	Virginia Waterleaf
HYLGLU	3	Hylodesmum glutinosim	Nt P-FORB	Pointed Tick Trefoil
HYLNUD	4	Hylodesmum nudiflorum	Nt P-FORB	Bare-Stemmed Tick Trefoil
HYLPAU	8	Hylodesmum pauciflorum	Nt P-FORB	Small-Flowered Tick Trefoil
HYMCAR	8	Hymenocallis caroliniana	Nt P-FORB	Spider Lily
HYMSCA	7	Hymenopappus scabiosaeus	Nt B-FORB	Old Plainsman
HYPADP	10	Hypericum adpressum	Nt P-FORB	Creeping St. John's Wort
HYPASC	10	Hypericum ascyron subsp. pyramidatum	Nt P-FORB	Great St. John's Wort
HYPDRU	4	Hypericum drummondii	Nt A-FORB	Nits And Lice
HYPGEN	5	Hypericum gentianoides	Nt A-FORB	Orange Grass
HYPGYM	7	Hypericum gymnanthum	Nt A-FORB	Clasping St. John's Wort
HYPHYP	8	Hypericum hypericoides	Nt P-FORB	Sand St. Andrew's Cross
HYPLOB	9	Hypericum lobocarpum	Nt P-FORB	Bushy St. John's Wort
HYPMAJ	10	Hypericum majus	Nt P-FORB	Large St. John's Wort
HYPMUT	4	Hypericum mutilum	Nt P-FORB	Weak St. John's Wort
HYPPER	*	HYPERICUM PERFORATUM	Ad P-FORB	Common St. John's Wort
HYPPRO	4	Hypericum prolificum	Nt SHRUB	Shrubby St. John's Wort
HYPPSE	3	Hypericum pseudomaculatum	Nt P-FORB	False Spotted St. John's Wort
HYPPUN	3	Hypericum punctatum	Nt P-FORB	Spotted St. John's Wort
HYPSPH	5	Hypericum sphaerocarpum	Nt P-FORB	Round-Fruited St. John's Wort
HYPSTR	6	Hypericum strangulum	Nt P-FORB	Common St. Andrew's Cross
HYPRAD	*	HYPOCHAERIS RADICATA	Ad P-FORB	Cat's Ear
HYPHIR	5	Hypoxis hirsuta	Nt P-FORB	Yellow Star Grass
ILEDEC	5	Ilex decidua	Nt SHRUB	Possum Haw
ILEOPA	7	Ilex opaca	Nt TREE	American Holly
ILEVER	10	Ilex verticillata	Nt SHRUB	Winterberry

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ILEVOM	*	ILEX VOMITORIA	Ad SHRUB	Yaupon
IMPBAL	*	IMPATIENS BALSAMINEA	Ad A-FORB	Garden Balsam
IMPCAP	3	Impatiens capensis	Nt A-FORB	Orange Jewelweed
IMPPAL	5	Impatiens pallida	Nt A-FORB	Yellow Jewelweed
INUBRI	*	INULA BRITANNICA	Ad P-FORB	British Yellowhead
INUHEL	*	INULA HELENIUM	Ad P-FORB	Elecampane
IODPIN	7	Iodanthus pinnatifidus	Nt P-FORB	Violet Cress
IONLIN	9	Ionactis linariifolius	Nt P-FORB	Flax-Leaved Aster
IPOAMN	*	IPOMOEA AMNICOLA	Ad P-FORB	Ivy-Leaved Morning Glory
IPOCOC	*	IPOMOEA COCCINEA	Ad A-FORB	Scarlet Morning-Glory
IPOHED	*	IPOMOEA HEDERACEA	Ad A-FORB	Red Morning Glory
IPOLAC	1	Ipomoea lacunosa	Nt A-FORB	Small Morning Glory
IPOPAN	2	Ipomoea pandurata	Nt P-FORB	Wild Sweet Potato
IPOPUR	*	IPOMOEA PURPUREA	Ad A-FORB	Common Morning Glory
IPOQUA	*	IPOMOEA QUAMOCLIT	Ad A-FORB	Cypress Vine
IPOTRI	*	IPOMOEA TRICOLOR	Ad A-FORB	Grannyvine
IPORUB	*	IPOMOPSIS RUBRA	Ad B-FORB	Standing Cypress
IRERHI	5	Iresine rhizomatosa	Nt P-FORB	Bloodleaf
IRIBRE	10	Iris brevicaulis	Nt P-FORB	Short-Stemmed Iris
IRICRI	8	Iris cristata	Nt P-FORB	Crested Iris
IRIFUL	9	Iris fulva	Nt P-FORB	Copper Iris
IRIGER	*	IRIS GERMANICA	Ad P-FORB	German Iris
IRIORI	*	IRIS ORIENTALIS	Ad P-FORB	Asian Iris
IRIPAL	*	IRIS PALLIDA	Ad P-FORB	Sweet Iris
IRIPSE	*	IRIS PSEUDOACORUS	Ad P-FORB	Yellow Iris
IRIPUM	*	IRIS PUMILA	Ad P-FORB	Dwarf Bearded Iris
IRIVER	*	IRIS VERNA	Ad P-FORB	Early Iris
IRIVIR	6	Iris virginica var. shrevei	Nt P-FORB	Blue Flag
ISATIN	*	ISATIS TINCTORIA	Ad P-FORB	Woad
ISOBUT	8	Isoetes butleri	Nt FERN	Butler's Quillwort
ISOENG	10	Isoetes engelmannii	Nt FERN	Engelmann's Quillwort
ISOMEL	7	Isoetes melanopoda	Nt FERN	Quillwort
ISOCAR	6	Isolepis carinata	Nt A-SEDGE	Keeled Bulrush
ISOMOL	8	Isolepis molesta	Nt A-SEDGE	Gulf Coast Bulrush
ISOBIT	5	Isopyrum biternatum	Nt P-FORB	False Rue Anemone
ISOMED	10	Isotria medeoloides	Nt P-FORB	Small Whorled Pogonia
ISOVER	10	Isotria verticillata	Nt P-FORB	Large Whorled Pogonia
ITEVIR	10	Itea virginica	Nt SHRUB	Virginia Willow
IVAANG	*	IVA ANGUSTIFOLIA	Ad A-FORB	Narrowleaf Marsh Elder

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
IVAANN	1	Iva annua	Nt A-FORB	Marsh Elder
JACTAM	*	JACQUEMONTIA TAMNIFOLIA	Ad A-FORB	Hairy Cluster Vine
JASNUD	*	JASMINUM NUDIFLORUM	Ad SHRUB	Winter Jasmine
JUGCIN	7	Juglans cinerea	Nt TREE	Butternut
JUGNIG	4	Juglans nigra	Nt TREE	Black Walnut
JUNACU	4	Juncus acuminatus	Nt P-FORB	Sharp-Fruited Rush
JUNALP	10	Juncus alpinoarticulatus	Nt P-FORB	Richardson's Rush
JUNBAL	10	Juncus balticus subsp. littoralis	Nt P-FORB	Lake Shore Rush
JUNBIF	5	Juncus biflorus	Nt P-FORB	Two-Flowered Rush
JUNBRC†	7	Juncus brachycarpus	Nt P-FORB	Short-Fruited Rush
JUNBRP†	7	Juncus brachyphyllus	Nt P-FORB	Small-Headed Rush
JUNBUF	3	Juncus bufonius	Nt A-FORB	Toad Rush
JUNCAN	10	Juncus canadensis	Nt P-FORB	Canadian Rush
JUNDEB	10	Juncus debilis	Nt P-FORB	Weak Rush
JUNDIF	5	Juncus diffusissimus	Nt P-FORB	Slimpod Rush
JUNDUD	6	Juncus dudleyi	Nt P-FORB	Dudley's Rush
JUNEFF	4	Juncus effusus subsp. solutus	Nt P-FORB	Common Rush
JUNFIL	10	Juncus filipendulus◀	Nt P-FORB	Glade Rush
JUNGER	*	JUNCUS GERARDII	Ad P-FORB	Black Grass
JUNINT	5	Juncus interior	Nt P-FORB	Inland Rush
JUNMAR	4	Juncus marginatus	Nt P-FORB	Grass-Leaved Rush
JUNNOT†	6	Juncus nodatus	Nt P-FORB	Stout Rush
JUNNOS†	10	Juncus nodosus	Nt P-FORB	Joint Rush
JUNSCI	9	Juncus scirpoides	Nt P-FORB	Round-Leaved Rush
JUNSEC	5	Juncus secundus	Nt P-FORB	Secund Rush
JUNSUB	10	Juncus subcaudatus	Nt P-FORB	Fen Rush
JUNTEA†	2	Juncus tenuis var. anthelatus	Nt P-FORB	Path Rush
JUNTET†	0	Juncus tenuis var. tenuis	Nt P-FORB	Path Rush
JUNTOR	4	Juncus torreyi	Nt P-FORB	Torrey's Rush
JUNVAL	10	Juncus validus	Nt P-FORB	Round-Head Rush
JUNASH	8	Juniperus ashei	Nt TREE	Ashe's Juniper
JUNVIR	2	Juniperus virginiana	Nt TREE	Red Cedar
JUSAME	5	Justicia americana	Nt P-FORB	Water Willow
JUSOVA	9	Justicia ovata	Nt P-FORB	Loose-Flower Water Willow
KALPAR	*	KALLSTROEMIA PARVIFLORA	Ad A-FORB	Small-Flowered Caltrop
KICELA	*	KICKXIA ELATINE	Ad A-FORB	Fluellin
KICSPU	*	KICKXIA SPURIA	Ad A-FORB	Female Fluellin
KNAARV	*	KNAUTIA ARVENSIS	Ad P-FORB	Field Scabiosa
KOCSCO	*	KOCHIA SCOPARIA	Ad A-FORB	Burning Bush

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
KOEMAC	6	Koeleria macrantha	Nt P-GRASS	June Grass
KOEPAN	*	KOELRUETERIA PANICULATA	Ad TREE	Golden Rain Tree
KOLAMA	*	KOLKWITZIA AMABILIS	Ad SHRUB	Beauty Bush
KRIBIF	5	Krigia biflora	Nt P-FORB	Orange False Dandelion
KRICAE	2	Krigia caespitosa	Nt A-FORB	Opposite-Leaved Dwarf Dandelion
KRIDAN	6	Krigia dandelion	Nt P-FORB	Potato Dandelion
KRIOCC	7	Krigia occidentalis	Nt A-FORB	Western Dwarf Dandelion
KRIVIR	3	Krigia virginica	Nt A-FORB	Common Dwarf Dandelion
KUMSTI	*	KUMMEROWIA STIPULACEA	Ad A-FORB	Korean Bush Clover
KUMSTR	*	KUMMEROWIA STRIATA	Ad A-FORB	Japanese Bush Clover
KYLGRA	*	KYLLINGA GRACILLIMA	Ad P-SEDGE	Pasture Spikesedge
KYLPUM	3	Kyllinga pumila	Nt A-SEDGE	Thin-Leaf Flatsedge
LABPUR	*	LABLAB PURPUREUS	Ad P-FORB	Hyacinth Bean
LACCAN	3	Lactuca canadensis	Nt B-FORB	Wild Lettuce
LACFLO	3	Lactuca floridana	Nt B-FORB	Blue Lettuce
LACHIR	4	Lactuca hirsuta	Nt A-FORB	Hairy Lettuce
LACLUD	10	Lactuca ludoviciana	Nt B-FORB	Western Wild Lettuce
LACSAL	*	LACTUCA SALIGNA	Ad B-FORB	Willow Lettuce
LACSER	*	LACTUCA SERRIOLA	Ad B-FORB	Prickly Lettuce
LACTAT	10	Lactuca tatarica subsp. pulchella	Nt P-FORB	Showy Blue Lettuce
LAGSIC	*	LAGENARIA SICERARIA	Ad A-FORB	Bottle Gourd
LAMAMP	*	LAMIUM AMPLEXICAULE	Ad P-FORB	Henbit
LAMHYB	*	LAMIUM HYBRIDUM	Ad A-FORB	Cut-Leaved Dead Nettle
LAMPUR	*	LAMIUM PURPUREUM	Ad P-FORB	Purple Dead Nettle
LAPCAN	4	Laportea canadensis	Nt P-FORB	Wood Nettle
LAPRED	*	LAPPULA REDOWSKII	Ad A-FORB	Hairy Stick-Seed
LAPSQU	*	LAPPULA SQUARROSA	Ad A-FORB	Beggar's Lice
LAPCOM	*	LAPSANA COMMUNIS	Ad A-FORB	Nipplewort
LATHIR	*	LATHYRUS HIRSUTUS	Ad A-FORB	Caley Pea
LATLAT	*	LATHYRUS LATIFOLIUS	Ad P-FORB	Everlasting Pea
LATPAL	10	Lathyrus palustris	Nt P-FORB	Marsh Vetchling
LATPUS	10	Lathyrus pusillus	Nt A-FORB	Singletary Vetchling
LATSYL	*	LATHYRUS SYLVESTRIS	Ad P-FORB	Flat Pea
LATTUB	*	LATHYRUS TUBEROSUS	Ad P-FORB	Dutch Mice
LATVEN	8	Lathyrus venosus	Nt P-FORB	Veiny Pea
LAVTRI	*	LAVATERA TRIMESTRIS	Ad A-FORB	Annual Mallow
LEAUNI	7	Leavenworthia uniflora	Nt A-FORB	Michaux's Leavenworthia
LECMUC	5	Lechea mucronata	Nt P-FORB	Hairy Pinweed
LECRAC	10	Lechea racemulosa	Nt P-FORB	Narrow-Fruited Pinweed

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
LECTEN	4	Lechea tenuifolia	Nt P-FORB	Slender-Leaved Pinweed
LEELEN	7	Leersia lenticularis	Nt P-GRASS	Catchfly Grass
LEEORY	3	Leersia oryzoides	Nt P-GRASS	Rice Cut Grass
LEEVIO†	7	Leersia virginica var. ovata◄	Nt P-GRASS	White Grass
LEEVIV†	4	Leersia virginica var. virginica◄	Nt P-GRASS	White Grass
LEIFLO	9	Leitneria floridana	Nt SHRUB	Corkwood
LEMAEQ	5	Lemna aequinoctialis	Nt P-FORB	Lesser Duckweed
LEMMIR†	4	Lemna minor	Nt P-FORB	Common Duckweed
LEMMIT†	6	Lemna minuta	Nt P-FORB	Least Duckweed
LEMOBS	7	Lemna obscura	Nt P-FORB	Little Duckweed
LEMPER	8	Lemna perpusilla	Nt P-FORB	Minute Duckweed
LEMTRI	10	Lemna trisulca	Nt P-FORB	Forked Duckweed
LEMTUR	10	Lemna turionifera	Nt P-FORB	Turion Duckweed
LEMVAL	7	Lemna valdiviana	Nt P-FORB	Pale Duckweed
LEOTAR	*	LEONTODON TARAXACOIDES	Ad P-FORB	Lesser Hawkbit
LEOCAR	*	LEONURUS CARDIACA	Ad P-FORB	Motherwort
LEOJAP	*	LEONURUS JAPONICUS	Ad B-FORB	Siberian Motherwort
LEOMAR	*	LEONURUS MARRUBIASTRUM	Ad B-FORB	Lion's Tail
LEPAPP	*	LEPIDIUM APPELIANUM	Ad P-FORB	Hairy Whitetop
LEPCAM	*	LEPIDIUM CAMPESTRE	Ad B-FORB	Field Cress
LEPCHA	*	LEPIDIUM CHALAPENSE	Ad P-FORB	Hoary Cress
LEPDEN	*	LEPIDIUM DENSIFLORUM◄	Ad A-FORB	Small Pepper Cress
LEPDID	*	LEPIDIUM DIDYMUM	Ad A-FORB	Wart Cress
LEPDRA	*	LEPIDIUM DRABA	Ad P-FORB	Common Whitetop
LEPLAT	*	LEPIDIUM LATIFOLIUM	Ad P-FORB	Broad-Leaved Pepper Cress
LEPPER	*	LEPIDIUM PERFOLIATUM	Ad A-FORB	Clasping Cress
LEPRUD	*	LEPIDIUM RUDERALE	Ad A-FORB	Stinking Peppercress
LEPVIR	0	Lepidium virginicum	Nt A-FORB	Common Pepper Cress
LEPDUB	*	LEPTOCHLOA DUBIA	Ad P-GRASS	Green Sprangletop
LEPFUF†	3	Leptochloa fusca subsp. fascicularis	Nt A-GRASS	Bearded Strangletop
LEPFUU†	*	LEPTOCHLOA FUSCA subsp. UNINERVIA	Ad A-GRASS	Mexican Sprangletop
LEPPAB†	3	Leptochloa panicea subsp. brachiata	Nt A-GRASS	Red Sprangletop
LEPPAM†	3	Leptochloa panicea subsp. mucronata	Nt A-GRASS	Red Sprangletop
LEPPAS†	5	Leptochloa panicoides	Nt A-GRASS	Amazon Strangletop
LESBIC	*	LESPEDEZA BICOLOR	Ad P-FORB	Bicolor Lespedeza
LESCAP	6	Lespedeza capitata	Nt P-FORB	Round-Headed Bush Clover
LESCUN	*	LESPEDEZA CUNEATA	Ad P-FORB	Silky Bush Clover
LESFRU	5	Lespedeza frutescens◄	Nt P-FORB	Violet Bush Clover
LESHIR	7	Lespedeza hirta	Nt P-FORB	Hairy Bush Clover

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
LESPRA	7	Lespedeza prairea◂	Nt P-FORB	Tallgrass Bush Clover
LESPRO	4	Lespedeza procumbens	Nt P-FORB	Trailing Bush Clover
LESREP	4	Lespedeza repens	Nt P-FORB	Creeping Bush Clover
LESSTU	7	Lespedeza stuevei	Nt P-FORB	Stueve's Bush Clover
LESTHU	*	LESPEDEZA THUNBERGII	Ad P-FORB	Tall Bush Clover
LESVIO	6	Lespedeza violacea	Nt P-FORB	Wandlike Bush Clover
LESVIR	5	Lespedeza virginica	Nt P-FORB	Slender Bush Clover
LEUVUL	*	LEUCANTHEMUM VULGARE	Ad P-FORB	Ox-Eye Daisy
LEUAES	*	LEUCOJUM AESTIVUM	Ad P-FORB	Snowflake
LEUMUL	3	Leucospora multifida	Nt A-FORB	Obe-Wan-Conobea
LEVOFF	*	LEVISTICUM OFFICINALE	Ad P-FORB	Lovage
LIAASP	6	Liatris aspera	Nt P-FORB	Rough Blazing Star
LIACYL	7	Liatris cylindracea	Nt P-FORB	Cylindrical Blazing Star
LIAMUC	10	Liatris mucronata	Nt P-FORB	Narrow-Leaf Gayfeather
LIAPUN	10	Liatris punctata	Nt P-FORB	Dotted Blazing Star
LIAPYC	6	Liatris pycnostachya	Nt P-FORB	Prairie Blazing Star
LIASCA	9	Liatris scariosa var. nieuwlandii	Nt P-FORB	Blazing Star
LIASPI	10	Liatris spicata	Nt P-FORB	Marsh Blazing Star
LIASQH†	6	Liatris squarrosa var. hirsuta	Nt P-FORB	Hairy Blazing Star
LIASQS†	6	Liatris squarrosa var. squarrosa	Nt P-FORB	Scaly Blazing Star
LIASQL†	8	Liatris squarrulosa	Nt P-FORB	Scabrous Blazing Star
LIGCAN	8	Ligusticum canadense	Nt P-FORB	Angelico
LIGOBT	*	LIGUSTRUM OBTUSIFOLIUM	Ad SHRUB	Border Privet
LIGOVA	*	LIGUSTRUM OVALIFOLIUM	Ad SHRUB	California Privet
LIGSIN	*	LIGUSTRUM SINENSE	Ad SHRUB	Chinese Privet
LIGVUL	*	LIGUSTRUM VULGARE	Ad SHRUB	European Privet
LILLAN	*	LILIUM LANCIFOLIUM	Ad P-FORB	Tiger Lily
LILMIC	7	Lilium michiganense	Nt P-FORB	Michigan Lily
LILPHI	10	Lilium philadelphicum var. andinum	Nt P-FORB	Prairie Lily
LILSUP	10	Lilium superbum	Nt P-FORB	Turk's-Cap Lily
LIMSPO	10	Limnobium spongia	Nt P-FORB	American Frogbit
LIMPIN	7	Limnosciadium pinnatum	Nt A-FORB	Pinnate Cynosciadium
LINVUL	*	LINARIA VULGARIS	Ad P-FORB	Butter-And-Eggs
LINBEN	5	Lindera benzoin	Nt SHRUB	Spicebush
LINMEL	10	Lindera melissifolia	Nt SHRUB	Pond Berry
LINDUA†	4	Lindernia dubia var. anagallidea◂	Nt A-FORB	Slender False Pimpernel
LINDUD†	4	Lindernia dubia var. dubia◂	Nt A-FORB	Slender False Pimpernel
LINFLO	10	Linum floridanum	Nt P-FORB	Florida Yellow Flax
LINMED	5	Linum medium var. texanum	Nt P-FORB	Small Yellow Flax

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
LINRIG	*	LINUM RIGIDUM	Ad A-FORB	Stiff-Stem Flax
LINSTR	6	Linum striatum	Nt P-FORB	Stiff Yellow Flax
LINSUL	5	Linum sulcatum	Nt A-FORB	Grooved Yellow Flax
LINUSI	*	LINUM USITATISSIMUM	Ad A-FORB	Common Flax
LINVIR	10	Linum virginianum	Nt P-FORB	Woodland Yellow Flax
LIPLIL	7	Liparis liliifolia	Nt P-FORB	Purple Twayblade
LIPLOE	10	Liparis loeselii	Nt P-FORB	Green Twayblade
LIPARI	7	Lipocarpha aristulata	Nt A-SEDGE	Glade Dwarf Bulrush
LIPDRU	8	Lipocarpha drummondii	Nt A-SEDGE	Sand Dwarf Bulrush
LIPMIC	5	Lipocarpha micrantha	Nt A-SEDGE	Common Dwarf Bulrush
LIPLAN	3	Lippia lanceolata	Nt P-FORB	Fog Fruit
LIPNOD	10	Lippia nodiflora	Nt P-FORB	Common Fog Fruit
LIQSTY	6	Liquidamber styraciflua	Nt TREE	Sweet Gum
LIRTUL	7	Liriodendron tulipifera	Nt TREE	Tulip Tree
LIRMUS	*	LIRIOPE MUSCARI	Ad P-FORB	Big Blue Lilyturf
LIRSPI	*	LIRIOPE SPICATA	Ad P-FORB	Creeping Lilyturf
LISAUS	10	Listera australis ◥	Nt P-FORB	Southern Twayblade
LITCAN	6	Lithospermum canescens	Nt P-FORB	Hoary Puccoon
LITCAR	7	Lithospermum carolinense	Nt P-FORB	Hairy Puccoon
LITINC	7	Lithospermum incisum	Nt P-FORB	Fringed Puccoon
LITLAT	9	Lithospermum latifolium	Nt P-FORB	Broad-Leaved Puccoon
LOBCAR	6	Lobelia cardinalis	Nt P-FORB	Cardinal Flower
LOBINF	3	Lobelia inflata	Nt A-FORB	Indian Tobacco
LOBPUB	10	Lobelia puberula	Nt P-FORB	Downy Lobelia
LOBSIP	4	Lobelia siphilitica	Nt P-FORB	Great Blue Lobelia
LOBSPI	5	Lobelia spicata	Nt P-FORB	Pale Spiked Lobelia
LOBMAR	*	LOBULARIA MARITIMA	Ad P-FORB	Sweet Alyssum
LOLPEA†	*	LOLIUM PERENNE var. ARISTATUM	Ad A-GRASS	Italian Rye Grass
LOLPEP†	*	LOLIUM PERENNE var. PERENNE	Ad P-GRASS	Perennial Rye Grass
LOLPES†	*	LOLIUM PERSICUM	Ad A-GRASS	Asian Rye Grass
LOLRIG	*	LOLIUM RIGIDUM	Ad P-GRASS	Swiss Rye Grass
LOLTEM	*	LOLIUM TEMULENTUM	Ad A-GRASS	Darnel
LOMFOE	9	Lomatium foeniculaceum	Nt P-FORB	Hairy Parsley
LONBEL	*	LONICERA × BELLA	Ad SHRUB	Showy Fly Honeysuckle
LONPER	*	LONICERA × PERPUSII	Ad SHRUB	Garden Honeysuckle
LONDIO	8	Lonicera dioica	Nt W-VINE	Red Honeysuckle
LONFLA	7	Lonicera flava	Nt W-VINE	Yellow Honeysuckle
LONFRA	*	LONICERA FRAGRANTISSIMA	Ad SHRUB	Winter Honeysuckle
LONJAP	*	LONICERA JAPONICA	Ad W-VINE	Japanese Honeysuckle

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
LONMAA	*	LONICERA MAACKII	Ad SHRUB	Amur Honeysuckle
LONRET	8	Lonicera reticulata	Nt W-VINE	Grape Honeysuckle
LONSEM	*	LONICERA SEMPERVIRENS	Ad W-VINE	Trumpet Honeysuckle
LOTCOR	*	LOTUS CORNICULATUS	Ad P-FORB	Bird's Foot Trefoil
LUDALT	4	Ludwigia alternifolia	Nt P-FORB	Seedbox
LUDDEC	6	Ludwigia decurrens	Nt P-FORB	Primrose Willow
LUDGLA	8	Ludwigia glandulosa	Nt P-FORB	Small-Flowered Water-Primrose
LUDGRA	*	LUDWIGIA GRANDIFLORA◂	Ad P-FORB	Uruguay Primrose Willow
LUDLEP	10	Ludwigia leptocarpa	Nt P-FORB	Hairy Primrose Willow
LUDLIN	10	Ludwigia linearis	Nt P-FORB	Narrow-Leaved Primrose Willow
LUDMIC	10	Ludwigia microcarpa	Nt P-FORB	Small-Fruited False Loosestrife
LUDPAL	4	Ludwigia palustris	Nt P-FORB	Marsh Purslane
LUDPEP	3	Ludwigia peploides subsp. glabrescens	Nt P-FORB	Creeping Primrose Willow
LUDPOL	6	Ludwigia polycarpa	Nt P-FORB	False Loosestrife
LUNANN	*	LUNARIA ANNUA	Ad B-FORB	Money Plant
LUZCAB†	4	Luzula campestris var. bulbosa	Nt P-FORB	Wood Rush
LUZCAE†	4	Luzula campestris var. echinata	Nt P-FORB	Wood Rush
LUZCAU†	4	Luzula campestris var. multiflora	Nt P-FORB	Wood Rush
LYCCOR	*	LYCHNIS CORONARIA	Ad P-FORB	Mullein Pink
LYCBAR	*	LYCIUM BARBARUM	Ad SHRUB	Matrimony Vine
LYCCHI	*	LYCIUM CHINENSE	Ad SHRUB	Chinese Matrimony Vine
LYCDEN	10	Lycopodium dendroideum	Nt FERN	Round-Branched Clubmoss
LYCDIG	8	Lycopodium digitatum	Nt FERN	Southern Ground-Cedar
LYCTRI	10	Lycopodium tristachyum	Nt FERN	Ground Cedar
LYCAME	4	Lycopus americanus	Nt P-FORB	Common Water Horehound
LYCASP	10	Lycopus asper	Nt P-FORB	Rough Water Horehound
LYCRUB	6	Lycopus rubellus	Nt P-FORB	Stalked Water Horehound
LYCUNI	8	Lycopus uniflorus	Nt P-FORB	Northern Bugleweed
LYCVIR	5	Lycopus virginicus	Nt P-FORB	Bugle Weed
LYGJUN	10	Lygodesmia juncea	Nt P-FORB	Skeleton Plant
LYOMAR	10	Lyonia mariana	Nt SHRUB	Stagger Bush
LYSCIL	5	Lysimachia ciliata	Nt P-FORB	Fringed Loosestrife
LYSHYB	7	Lysimachia hybrida	Nt P-FORB	Hybrid Loosestrife
LYSLAN	4	Lysimachia lanceolata	Nt P-FORB	Lance-Leaved Loosestrife
LYSNUM	*	LYSIMACHIA NUMMULARIA	Ad P-FORB	Moneywort
LYSQUA	8	Lysimachia quadriflora	Nt P-FORB	Narrow-Leaved Loosestrife
LYSRAD	10	Lysimachia radicans	Nt P-FORB	Creeping Loosestrife
LYSTER	10	Lysimachia terrestris	Nt P-FORB	Swamp Candles

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
LYSTHY	10	Lysimachia thyrsiflora	Nt P-FORB	Tufted Loosestrife
LYSVUL	*	LYSIMACHIA VULGARIS	Ad P-FORB	Garden Loosestrife
LYTALA	6	Lythrum alatum	Nt P-FORB	Winged Loosestrife
LYTSAL	*	LYTHRUM SALICARIA	Ad P-FORB	Purple Loosestrife
MACPOM	*	MACLURA POMIFERA	Ad TREE	Osage Orange
MAGACU	7	Magnolia acuminata	Nt TREE	Cucumber Tree
MAGTRI	*	MAGNOLIA TRIPETALA	Ad TREE	Umbrella Tree
MAIRAC	4	Maianthemum racemosum	Nt P-FORB	Feathery False Solomon's Seal
MAISTE	7	Maianthemum stellatum	Nt P-FORB	Starry False Solomon's Seal
MALUNI	9	Malaxis unifolia	Nt P-FORB	Green Adder's Mouth
MALSOU	*	MALUS × SOULARDII	Ad TREE	Soulard Crab
MALUAN†	10	Malus angustifolia	Nt TREE	Wild Crab
MALBAC	*	MALUS BACCATA	Ad TREE	Siberian Crab
MALCOR	5	Malus coronaria	Nt TREE	Wild Sweet Crab
MALDOM	*	MALUS DOMESTICA	Ad TREE	Apple
MALFLO	*	MALUS FLORIBUNDA	Ad TREE	Japanese Crab
MALIOE	3	Malus ioensis	Nt TREE	Iowa Crab
MALSIE	*	MALUS SIEBOLDII	Ad SHRUB	Toringo Crab
MALMOS	*	MALVA MOSCHATA	Ad P-FORB	Musk Mallow
MALNEG	*	MALVA NEGLECTA	Ad B-FORB	Common Mallow
MALPAR	*	MALVA PARVIFLORA	Ad A-FORB	Little Mallow
MALPUS	*	MALVA PUSILLA	Ad A-FORB	Round-Leaved Mallow
MALSYL	*	MALVA SYLVESTRIS	Ad B-FORB	High Mallow
MALVER	*	MALVA VERTICILLATA	Ad A-FORB	Curled Mallow
MALVAN†	6	Malvastrum angustum	Nt A-FORB	False Mallow
MANVIR	7	Manfreda virginica	Nt P-FORB	American Aloe
MARVUL	*	MARRUBIUM VULGARE	Ad P-FORB	Horehound
MARCAC†	9	Marshallia caespitosa var. caespitosa	Nt P-FORB	Barbara's Buttons
MARCAS†	10	Marshallia caespitosa var. signata	Nt P-FORB	Narrow-Leaved Barbara's Buttons
MARMUT	*	MARSILEA MUTICA	Ad FERN	Australian Water Clover
MARQUA	*	MARSILEA QUADRIFOLIA	Ad FERN	European Water-Clover
MATBAL	8	Matelea baldwyniana	Nt P-FORB	White Climbing Milkweed
MATDEC	5	Matelea decipiens	Nt P-FORB	Climbing Milkweed
MATCHA	*	MATRICARIA CHAMOMILLA	Ad A-FORB	Chamomile
MATDIS	*	MATRICARIA DISCOIDEA	Ad A-FORB	Pineapple Weed
MATSTR	8	Matteuccia struthiopteris var. pensylvanica	Nt FERN	Ostrich Fern
MAZPUM	*	MAZUS PUMILUS	Ad P-FORB	Japanese Magus
MECACU	10	Mecardonia acuminata	Nt P-FORB	Bracted Water Hyssop

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
MEDVIR	10	Medeola virginiana	Nt P-FORB	Indian Cucumber Root
MEDARA	*	MEDICAGO ARABICA	Ad A-FORB	Spotted Medick
MEDLUP	*	MEDICAGO LUPULINA	Ad A-FORB	Black Medick
MEDMIN	*	MEDICAGO MINIMA	Ad A-FORB	Tiny Bur Clover
MEDPOL	*	MEDICAGO POLYMORPHA	Ad A-FORB	Bur Clover
MEDSAT	*	MEDICAGO SATIVA	Ad P-FORB	Alfalfa
MELCIN	*	MELAMPODIUM CINEREUM var. RAMOSISSIMUM	Ad P-FORB	Hoary Blackfoot
MELVIR	9	Melanthium virginicum	Nt P-FORB	Bunch Flower
MELAZE	*	MELIA AZEDARACH	Ad TREE	Chinaberry Tree
MELMUT	10	Melica mutica◀	Nt P-GRASS	Narrow Melic Grass
MELNIT	6	Melica nitens	Nt P-GRASS	Tall Melic Grass
MELALB	*	MELILOTUS ALBUS	Ad B-FORB	White Sweet Clover
MELOFF	*	MELILOTUS OFFICINALE	Ad B-FORB	Yellow Sweet Clover
MELOFS†	*	MELISSA OFFICINALIS	Ad P-FORB	Common Balm
MELCOR	*	MELOCHIA CORCHORIFOLIA	Ad A-FORB	Chocolate Weed
MELPEN	8	Melothria pendula	Nt P-FORB	Creeping Cucumber
MENICA†	4	Menispermum canadense	Nt W-VINE	Moonseed
MENGRA	*	MENTHA × GRACILIS	Ad P-FORB	Little-Leaved Mint
MENPIP	*	MENTHA × PIPERITA	Ad P-FORB	Peppermint
MENAQU	*	MENTHA AQUATICA var. CITRATA	Ad P-FORB	Lemon Mint
MENTCA†	5	Mentha canadensis	Nt P-FORB	Wild Mint
MENLON	*	MENTHA LONGIFOLIA	Ad P-FORB	Wavy Mint
MENSPI	*	MENTHA SPICATA	Ad P-FORB	Spearmint
MENALB	*	MENTZELIA ALBESCENS	Ad P-FORB	Wavyleaf Stickleaf
MENNUD	*	MENTZELIA NUDA	Ad P-FORB	Bractless Stickleaf
MENOLI	6	Mentzelia oligosperma	Nt P-FORB	Glade Stickleaf
MENTRI	10	Menyanthes trifoliata	Nt P-FORB	Buckbean
MERVIR	6	Mertensia virginica	Nt P-FORB	Virginia Bluebells
MICPEN	10	Micranthes pensylvanica var. forbesii	Nt P-FORB	Swamp Saxifrage
MICTEX	9	Micranthes texana	Nt P-FORB	Texas Saxifrage
MICVIR	7	Micranthes virginiensis	Nt P-FORB	Early Saxifrage
MICVIM	*	MICROSTEGIUM VIMINEUM	Ad A-GRASS	Eulalia
MICPER	*	MICROTHLASPI PERFOLIATUM	Ad A-FORB	Perfoliate Pennycress
MIKSCA	5	Mikania scandens	Nt P-FORB	Climbing Hempweed
MIMQUA	6	Mimosa quadrivalvis var. nuttallii	Nt P-FORB	Sensitive Briar
MIMALA	5	Mimulus alatus	Nt P-FORB	Winged Monkey Flower
MIMGLA	10	Mimulus glabratus	Nt P-FORB	Yellow Monkey Flower
MIMRIN	5	Mimulus ringens	Nt P-FORB	Monkey Flower
MINMIC	9	Minuartia michauxii	Nt P-FORB	Stiff Sandwort

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
MINMUS	10	Minuartia muscorum	Nt A-FORB	Pitcher's Sandwort
MINPAT	7	Minuartia patula	Nt A-FORB	Slender Sandwort
MIRALB	5	Mirabilis albida	Nt P-FORB	Pale Umbrellawort
MIRLIN	8	Mirabilis linearis	Nt P-FORB	Narrow-Leaved Umbrellawort
MIRNYC	0	Mirabilis nyctaginea	Nt P-FORB	Wild Four O'Clock
MISSAC	*	MISCANTHUS SACCHARIFLORUS	Ad P-GRASS	Amur Silvergrass
MISSIN	*	MISCANTHUS SINENSIS	Ad P-GRASS	Silver Grass
MITREP	7	Mitchella repens	Nt P-FORB	Partridge Berry
MITDIP	8	Mitella diphylla	Nt P-FORB	Bishop's Cap
MITPET	10	Mitreola petiolata	Nt A-FORB	Miterwort
MOELAT	10	Moehringia lateriflora	Nt P-FORB	Grove Sandwort
MOLVER	*	MOLLUGO VERTICILLATA	Ad A-FORB	Carpet Weed
MONBRA	5	Monarda bradburiana	Nt P-FORB	Bradbury Bee Balm
MONCIT	8	Monarda citriodora	Nt A-FORB	Lemon Bee Balm
MONCLI	10	Monarda clinopodia	Nt P-FORB	Basil Bee Balm
MONDID	*	MONARDA DIDYMA	Ad P-FORB	Oswego Tea
MONFIS	4	Monarda fistulosa	Nt P-FORB	Wild Bergamot
MONPEC	*	MONARDA PECTINATA	Ad A-FORB	Plains Bee Balm
MONPUA†	10	Monarda punctata var. arkansana◄	Nt P-FORB	Arkansas Bee Balm
MONPUO†	*	MONARDA PUNCTATA var. OCCIDENTALIS	Ad P-FORB	Spotted Bee Balm
MONPUV†	7	Monarda punctata var. villicaulis	Nt P-FORB	Horsemint
MONNUT	*	MONOLEPIS NUTTALLIANA	Ad A-FORB	Poverty Weed
MONHYP	8	Monotropa hypopitys	Nt P-FORB	Pinesap
MONUNI	7	Monotropa uniflora	Nt P-FORB	Indian Pipe
MORALB	*	MORUS ALBA	Ad TREE	White Mulberry
MORRUB	4	Morus rubra	Nt TREE	Red Mulberry
MUHASP	1	Muhlenbergia asperifolia	Nt P-GRASS	Scratch Grass
MUHBUS	6	Muhlenbergia bushii	Nt P-GRASS	Short-Leaved Satin Grass
MUHCAP	9	Muhlenbergia capillaris	Nt P-GRASS	Pink Satin Grass
MUHCUS	10	Muhlenbergia cuspidata	Nt P-GRASS	Prairie Satin Grass
MUHFRO	3	Muhlenbergia frondosa	Nt P-GRASS	Common Satin Grass
MUHGLA	7	Muhlenbergia glabrifloris	Nt P-GRASS	Smooth Satin Grass
MUHMEX	6	Muhlenbergia mexicana	Nt P-GRASS	Leafy Satin Grass
MUHRAC	4	Muhlenbergia racemosa	Nt P-GRASS	Upland Wild Timothy
MUHSCH	0	Muhlenbergia schreberi	Nt P-GRASS	Nimblewill
MUHSOB	4	Muhlenbergia sobolifera	Nt P-GRASS	Rock Satin Grass
MUHSYL	5	Muhlenbergia sylvatica	Nt P-GRASS	Woodland Satin Grass
MUHTEN	6	Muhlenbergia tenuiflora	Nt P-GRASS	Slender Satin Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
MUSBOT	*	MUSCARI BOTRYOIDES	Ad P-FORB	Common Grape Hyacinth
MUSCOM	*	MUSCARI COMOSUM	Ad P-FORB	Tassel Grape Hyacinth
MUSRAC	*	MUSCARIA RACEMOSUM	Ad P-FORB	Starch Grape Hyacinth
MYOMAC	3	Myosotis macrosperma	Nt A-FORB	White Forget-Me-Not
MYOSCO	*	MYOSOTIS SCORPIOIDES	Ad P-FORB	Common Forget-Me-Not
MYOSTR	*	MYOSOTIS STRICTA	Ad A-FORB	Small-Flowered Forget-Me-Not
MYOVER	2	Myosotis verna	Nt A-FORB	Spring Forget-Me-Not
MYOAQU	*	MYOSOTON AQUATICUM	Ad P-FORB	Water Chickweed
MYOMIN	0	Myosurus minimus	Nt A-FORB	Mousetail
MYRAQU	*	MYRIOPHYLLUM AQUATICUM	Ad P-FORB	Parrot's Feather
MYRHET	8	Myriophyllum heterophyllum	Nt P-FORB	Various-Leaved Water Milfoil
MYRPIN	7	Myriophyllum pinnatum	Nt P-FORB	Rough Water Milfoil
MYRSIB	*	MYRIOPHYLLUM SIBIRICUM◀	Ad P-FORB	European Water Milfoil
MYRSPI	*	MYRIOPHYLLUM SPICATUM	Ad P-FORB	Pale Water Milfoil
NAJFLE	10	Najas flexilis	Nt A-FORB	Slender Naiad
NAJGRA	8	Najas gracillima	Nt A-FORB	Slender Water-Nymph
NAJGUA	6	Najas guadalupensis	Nt A-FORB	Southern Naiad
NAJMIN	*	NAJAS MINOR	Ad A-FORB	Brittle Naiad
NARPOE	*	NARCISSUS POETICUS	Ad P-FORB	Poet's Narcissus
NARPSE	*	NARCISSUS PSEUDO-NARCISSUS	Ad P-FORB	Daffodil
NASOFF	*	NASTURTIUM OFFICINALE	Ad P-FORB	Water Cress
NELLUT	6	Nelumbo lutea	Nt P-FORB	American Lotus
NELNUC	*	NELUMBO NUCIFERA	Ad P-FORB	Sacred Lotus
NEMGEM	10	Nemastylis geminiflora	Nt P-FORB	Celestial Lily
NEMNUT	9	Nemastylis nuttallii	Nt P-FORB	Nuttall's Prairie Iris
NEPCAT	*	NEPETA CATARIA	Ad P-FORB	Catnip
NESPAN	*	NESLIA PANICULATA	Ad A-FORB	Ball Mustard
NEVALA	10	Neviusia alabamensis	Nt SHRUB	Snow Wreath
NICPHY	*	NICANDRA PHYSALODES	Ad A-FORB	Apple Of Peru
NICLON	*	NICOTIANA LONGIFLORA	Ad A-FORB	Long-Flowered Tobacco
NICRUS	*	NICOTIANA RUSTICA	Ad A-FORB	Wild Tobacco
NICTAB	*	NICOTIANA TABACUM	Ad A-FORB	Tobacco
NOTCUS	10	Nothocalis cuspidata	Nt P-FORB	Prairie Dandelion
NOTBIV	4	Nothoscordum bivalve	Nt P-FORB	False Garlic
NUPADA†	6	Nuphar advena subsp. advena	Nt P-FORB	Yellow Pond Lily
NUPADO†	6	Nuphar advena subsp. ozarkana	Nt P-FORB	Ozark Spatterdock
NUTCAN	3	Nuttallanthus canadensis	Nt A-FORB	Small Blue Toadflax
NUTTEX	3	Nuttallanthus texanus	Nt A-FORB	Large Blue Toadflax

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
NYMODO	7	Nymphaea odorata	Nt P-FORB	White Water Lily
NYMPEL	*	NYMPHOIDES PELTATA	Ad P-FORB	Fragrant Water Lily
NYSAQU	10	Nyssa aquatica	Nt TREE	Water Tupelo
NYSBIF	10	Nyssa biflora	Nt TREE	Swamp Black Gum
NYSSYL	5	Nyssa sylvatica	Nt TREE	Black Gum
OBOVIR	10	Obolaria virginica	Nt P-FORB	Pennywort
OCIBAS	*	OCIMUM BASILICUM	Ad A-FORB	Basil
OENJAV	*	OENANTHE JAVANICA	Ad P-FORB	Water Celery
OENBIE	0	Oenothera biennis	Nt B-FORB	Common Evening Primrose
OENCLE	5	Oenothera clelandii	Nt B-FORB	Cleland's Evening Primrose
OENFRF†	10	Oenothera fruticosa subsp. fruticosa	Nt P-FORB	Sundrops
OENFRG†	10	Oenothera fruticosa subsp. glauca	Nt P-FORB	Glandular Snowdrops
OENGRA	5	Oenothera grandis	Nt A-FORB	Showy Ragged Evening Primrose
OENHET	*	OENOTHERA HETEROPHYLLA	Ad B-FORB	Four-Point Evening Primrose
OENLAC	1	Oenothera laciniata	Nt A-FORB	Ragged Evening Primrose
OENLIN	4	Oenothera linifolia	Nt A-FORB	Thread-Leaved Sundrops
OENMAC	7	Oenothera macrocarpa	Nt P-FORB	Missouri Primrose
OENNUT	3	Oenothera nutans	Nt B-FORB	Nodding Evening Primrose
OENPAR	5	Oenothera parviflora	Nt B-FORB	Northern Evening Primrose
OENPER	10	Oenothera perennis	Nt P-FORB	Small Sundrops
OENPIL	6	Oenothera pilosella	Nt P-FORB	Prairie Sundrops
OENRHO	5	Oenothera rhombipetala	Nt B-FORB	Sand Primrose
OENSPE	2	Oenothera speciosa	Nt P-FORB	Showy Evening Primrose
OENTRI	9	Oenothera triloba	Nt A-FORB	Stemless Evening Primrose
OENVIL	2	Oenothera villosa	Nt B-FORB	Hairy Evening Primrose
OLDBOS	8	Oldenlandia boscii	Nt P-FORB	Bosc's Bluets
OLDUNI	10	Oldenlandia uniflora	Nt A-FORB	Clustered Bluets
OLIALB	9	Oligoneuron album	Nt P-FORB	Stiff Aster
OLIRID	10	Oligoneuron riddellii	Nt P-FORB	Riddell's Goldenrod
OLIRIG	5	Oligoneuron rigidum	Nt P-FORB	Stiff Goldenrod
ONOSEN	6	Onoclea sensibilis	Nt FERN	Sensitive Fern
ONOACA	*	ONOPORDUM ACANTHIUM	Ad B-FORB	Scotch Thistle
ONOMOH†	4	Onosmodium molle subsp. hispidissimum	Nt P-FORB	Marbleseed
ONOMOO†	4	Onosmodium molle subsp. occidentale	Nt P-FORB	False Gromwell
ONOMOS†	4	Onosmodium molle subsp. subsetosum	Nt P-FORB	Ozark False Gromwell
OPHCRO	6	Ophioglossum crotalophoroides	Nt FERN	Bulbous Adder's Tongue
OPHENG	7	Ophioglossum engelmannii	Nt FERN	Glade Adder's Tongue
OPHPET	6	Ophioglossum petiolatum	Nt FERN	Stalked Adder's Tongue
OPHVUL	7	Ophioglossum vulgatum	Nt FERN	Adder's Tongue

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
OPUHUM	4	Opuntia humifusa	Nt SHRUB	Eastern Prickly Pear
OPUMAC	10	Opuntia macrorhiza	Nt SHRUB	Twinspine Prickly Pear
OPUPOL	10	Opuntia polyacantha	Nt SHRUB	Plains Prickly Pear
ORBONO	7	Orbexilum onobrychis	Nt P-FORB	French Grass
ORBPED	6	Orbexilum pedunculatum	Nt P-FORB	Sampson's Snakeroot
ORIVUL	*	ORIGANUM VULGARE	Ad P-FORB	Oregano
ORNNUT	*	ORNITHOGALUM NUTANS	Ad P-FORB	Nodding Star-Of-Bethlehem
ORNUMB	*	ORNITHOGALUM UMBELLATUM	Ad P-FORB	Star-Of-Bethlehem
OROLUD	10	Orobanche ludoviciana	Nt P-FORB	Louisiana Broom Rape
ORORIP	7	Orobanche riparia	Nt P-FORB	River Broom Rape
OROUNI	7	Orobanche uniflora	Nt P-FORB	One-Flowered Broom Rape
ORYSAT	*	ORYZA SATIVA	Ad A-GRASS	Rice
ORYRAC	10	Oryzopsis racemosa	Nt P-GRASS	Black-Seeded Rice Grass
OSMOCL†	3	Osmorhiza claytonii	Nt P-FORB	Hairy Sweet Cicely
OSMOLO†	3	Osmorhiza longistylis	Nt P-FORB	Smooth Sweet Cicely
OSMUCI†	8	Osmunda cinnamomea	Nt FERN	Cinnamon Fern
OSMUCL†	7	Osmunda claytoniana	Nt FERN	Interrupted Fern
OSMURE†	7	Osmunda regalis var. spectabilis	Nt FERN	Royal Fern
OSTVIR	4	Ostrya virginiana	Nt TREE	Ironwood
OTTALI	*	OTTELIA ALISMOIDES	Ad P-FORB	Duck Lettuce
OXACOR	*	OXALIS CORNICULATA	Ad P-FORB	Creeping Wood Sorrel
OXADIL	0	Oxalis dillenii	Nt P-FORB	Yellow Wood Sorrel
OXAFLO	5	Oxalis florida	Nt P-FORB	Swamp Wood Sorrel
OXASTR	0	Oxalis stricta	Nt P-FORB	Common Wood Sorrel
OXAVIO	5	Oxalis violacea	Nt P-FORB	Violet Wood Sorrel
OXYRIG	7	Oxypolis rigidior	Nt P-FORB	Cowbane
OXYLAM	10	Oxytropis lambertii	Nt P-FORB	Loco Weed
PACPRO	*	PACHYSANDRA PROCUMBENS	Ad P-FORB	Allegheny Spurge
PACAUR	6	Packera aurea	Nt P-FORB	Common Golden Ragwort
PACGLA	1	Packera glabella	Nt A-FORB	Butterweed
PACOBO	4	Packera obovata	Nt P-FORB	Round-Leaved Ragwort
PACPAU	6	Packera paupercula	Nt P-FORB	Balsam Ragwort
PACPLA	6	Packera plattensis	Nt P-FORB	Prairie Ragwort
PACPSE	6	Packera pseudaurea var. semicordata	Nt P-FORB	Western Golden Ragwort
PACTOM	10	Packera tomentosa	Nt P-FORB	Wooly Ragwort
PALCAL	5	Palafoxia callosa	Nt A-FORB	Small Palafoxia
PANQUI	8	Panax quinquefolius	Nt P-FORB	Ginseng
PANANC	3	Panicum anceps	Nt P-GRASS	Beaked Panic Grass
PANCAP	0	Panicum capillare	Nt A-GRASS	Old Witch Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
PANDIC	0	Panicum dichotomiflorum	Nt A-GRASS	Knee Grass
PANFLE	3	Panicum flexile	Nt A-GRASS	Wiry Panic Grass
PANGAT	4	Panicum gattingeri◀	Nt A-GRASS	Gattinger's Witch Grass
PANLON	10	Panicum longifolium◀	Nt P-GRASS	Long-Leaved Panic Grass
PANMIL	*	PANICUM MILIACEUM	Ad A-GRASS	Broom-Corn Millet
PANOBT	*	PANICUM OBTUSUM	Ad P-GRASS	Blunt Panic Grass
PANPHI	4	Panicum philadelphicum	Nt A-GRASS	Philadelphia Panic Grass
PANRIG	3	Panicum rigidulum	Nt P-GRASS	Munro Grass
PANVER	10	Panicum verrucosum	Nt A-GRASS	Warty Panic Grass
PANVIR	4	Panicum virgatum	Nt P-GRASS	Switch Grass
PAPDUB	*	PAPAVER DUBIUM	Ad A-FORB	Blind Eyes
PAPRHO	*	PAPAVER RHOEAS	Ad A-FORB	Corn Poppy
PAPSOM	*	PAPAVER SOMNIFERUM	Ad A-FORB	Common Poppy
PARPEN	3	Parietaria pensylvanica	Nt A-FORB	Pellitory
PARGRA	10	Parnassia grandifolia	Nt P-FORB	Grass-Of-Parnassus
PARCAN	4	Paronychia canadensis	Nt A-FORB	Tall Forked Chickweed
PARFAS	4	Paronychia fastigiata	Nt A-FORB	Low Forked Chickweed
PARVIR	10	Paronychia virginica	Nt P-FORB	Broom Whitlow-Wort
PARHIS	9	Parthenium hispidum◀	Nt P-FORB	Hairy Feverfew
PARHYS	*	PARTHENIUM HYSTEROPHORUS	Ad A-FORB	Santa Maria
PARINT	6	Parthenium integrifolium	Nt P-FORB	Wild Quinine
PARQUI	3	Parthenocissus quinquefolia	Nt W-VINE	Virginia Creeper
PARTRI	*	PARTHENOCISSUS TRICUSPIDATA	Ad W-VINE	Boston Ivy
PARVIT	3	Parthenocissus vitacea	Nt W-VINE	Thicket Creeper
PASSMI	0	Pascopyrum smithii	Nt P-GRASS	Western Wheat Grass
PASGEM	*	PASPALIDIUM GEMINATUM	Ad P-GRASS	Water Panic Grass
PASBIF	10	Paspalum bifidum	Nt P-GRASS	Pitchfork Lens Grass
PASDIL	*	PASPALUM DILATATUM	Ad P-GRASS	Dallis Grass
PASDSS†	10	Paspalum dissectum	Nt P-GRASS	Mudbank Lens Grass
PASDST†	*	PASPALUM DISTICHUM	Ad P-GRASS	Knotgrass
PASFLO	4	Paspalum floridanum	Nt P-GRASS	Florida Lens Grass
PASLAC†	3	Paspalum laeve var. circulare	Nt P-GRASS	Smooth Lens Grass
PASLAL†	2	Paspalum laeve var. laeve	Nt P-GRASS	Smooth Lens Grass
PASPUB	3	Paspalum pubiflorum	Nt P-GRASS	Hairy-Flowered Lens Grass
PASREP	5	Paspalum repens	Nt P-GRASS	Water Lens Grass
PASSCI†	3	Paspalum setaceum var. ciliatifolium	Nt P-GRASS	Hairy Lens Grass
PASSMU†	3	Paspalum setaceum var. muhlenbergii	Nt P-GRASS	Hairy Lens Grass
PASSSE†	7	Paspalum setaceum var. setaceum	Nt P-GRASS	Slender Lens Grass
PASSST†	5	Paspalum setaceum var. stramineum	Nt P-GRASS	Bush's Lens Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
PASURV	*	PASPALUM URVILLEI	Ad P-GRASS	Vasey Grass
PASINC	2	Passiflora incarnata	Nt P-FORB	Passion Flower
PASLUT	4	Passiflora lutea	Nt P-FORB	Yellow Passion Flower
PASSAT	*	PASTINACA SATIVA	Ad B-FORB	Wild Parsnip
PAUTOM	*	PAULOWNIA TOMENTOSA	Ad TREE	Empress Tree
PEDCAN	5	Pedicularis canadensis	Nt P-FORB	Lousewort
PEDLAN	9	Pedicularis lanceolata	Nt P-FORB	Swamp Lousewort
PEDARG	9	Pediomelum argophyllum	Nt P-FORB	Silvery Scurfy pea
PEDESC	10	Pediomelum esculentum	Nt P-FORB	Prairie Turnip
PEDTEN	8	Pediomelum tenuiflorum	Nt P-FORB	Scurfy Pea
PELGAS	10	Pellaea × gastonyi	Nt FERN	Gastony's Cliff Brake
PELATR	7	Pellaea atropurpurea	Nt FERN	Purple Cliff Brake
PELGLA	9	Pellaea glabella	Nt FERN	Smooth Cliff Brake
PELVIR	10	Peltandra virginica	Nt P-FORB	Arrow Arum
PENALO	*	PENNISETUM ALOPECUROIDES	Ad P-GRASS	Fountain Grass
PENAME	*	PENNISETUM AMERICANUM	Ad A-GRASS	Pearl Millet
PENSET	*	PENNISETUM SETACEUM	Ad P-GRASS	Crimson Fountaingrass
PENARK	8	Penstemon arkansanus	Nt P-FORB	Arkansas Beard-Tongue
PENCOC†	10	Penstemon cobaea var. cobaea◀	Nt P-FORB	Showy Beard Tongue
PENCOP†	10	Penstemon cobaea var. purpureus◀	Nt P-FORB	Cobea Beard-Tongue
PENDIG	3	Penstemon digitalis	Nt P-FORB	Foxglove Beard Tongue
PENGRA	8	Penstemon grandiflorus	Nt P-FORB	Large-Flowered Beard Tongue
PENPAL	5	Penstemon pallidus	Nt P-FORB	Pale Beard Tongue
PENTEN	3	Penstemon tenuis	Nt P-FORB	Brazos Beard Tongue
PENTUB	6	Penstemon tubaeflorus	Nt P-FORB	Funnel-Form Beard Tongue
PENSED	3	Penthorum sedoides	Nt P-FORB	Ditch Stonecrop
PERIAM†	8	Perideridia americana	Nt P-FORB	American Perideridia
PERFRU	*	PERILLA FRUTESCENS	Ad A-FORB	Beefsteak Plant
PERAMM†	5	Persicaria amphibia var. emersa	Nt P-FORB	Water Knotweed
PERAMS†	8	Persicaria amphibia var. stipulacea	Nt P-FORB	Water Heartsease
PERARI	10	Persicaria arifolia	Nt A-FORB	Halberd-Leaved Tearthumb
PERBIC	5	Persicaria bicornis	Nt A-FORB	Pink Smartweed
PERGLA	6	Persicaria glabra	Nt P-FORB	Dense-Flowered Smartweed
PERHYR†	3	Persicaria hydropiper	Nt A-FORB	Water Pepper
PERHYS†	4	Persicaria hydropiperoides	Nt P-FORB	Mild Water Pepper
PERLAP	0	Persicaria lapathifolia	Nt A-FORB	Heartsease
PERLON	*	PERSICARIA LONGISETA	Ad A-FORB	Creeping Smartweed
PERMAC	*	PERSICARIA MACULOSA	Ad A-FORB	Lady's Thumb

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
PERORI	*	PERSICARIA ORIENTALIS	Ad A-FORB	Kiss-Me-Over-The-Garden-Gate
PERPEN	1	Persicaria pensylvanica	Nt A-FORB	Pennsylvania Knotweed
PERPUN	3	Persicaria punctata	Nt A-FORB	Dotted Smartweed
PERROB	9	Persicaria robustior	Nt P-FORB	Stout Smartweed
PERSAG	4	Persicaria sagittata	Nt A-FORB	Arrow-Leaved Tearthumb
PERSET	5	Persicaria setacea	Nt P-FORB	Bog Smartweed
PERVIR	1	Persicaria virginiana	Nt P-FORB	Virginia Knotweed
PETPRO	*	PETROHAGIA PROLIFERA	Ad A-FORB	Childing Pink
PETATK	*	PETUNIA × ATKINSIANA	Ad A-FORB	White Petunia
PETAXI	*	PETUNIA AXILLARIS	Ad A-FORB	Large White Petunia
PETINT	*	PETUNIA INTEGRIFOLIA	Ad A-FORB	Violet Petunia
PHABIP	5	Phacelia bipinnatifida	Nt B-FORB	Forest Phacelia
PHACOV	8	Phacelia covillei	Nt A-FORB	Coville's Phacelia
PHAGIL	3	Phacelia gilioides	Nt A-FORB	Small-Flowered Phacelia
PHAHIR	4	Phacelia hirsuta	Nt A-FORB	Hairy Phacelia
PHAPUR	4	Phacelia purshii	Nt A-FORB	Miami Mist
PHARAN	6	Phacelia ranunculacea	Nt A-FORB	Blue Phacelia
PHAARU	*	PHALARIS ARUNDINACEA	Ad P-GRASS	Reed Canary Grass
PHABRA	*	PHALARIS BRACHYSTACHYS	Ad A-GRASS	Shortspike Canary Grass
PHACAN	*	PHALARIS CANARIENSIS	Ad A-GRASS	Canary Grass
PHACAR	1	Phalaris caroliniana	Nt A-GRASS	May Grass
PHALUN	*	PHASEOLUS LUNATUS	Ad A-FORB	Lima Bean
PHAPOL	7	Phaseolus polystachios	Nt P-FORB	Wild Bean
PHAVUL	*	PHASEOLUS VULGARIS	Ad A-FORB	Bush Bean
PHEHEX	8	Phegoteris hexagonoptera	Nt FERN	Broad Beech Fern
PHEAMU	*	PHELLODENDRON AMURENSE	Ad TREE	Amur Cork Tree
PHECAL	8	Phemeranthus calycinus	Nt P-FORB	Fame Flower
PHEPAR	10	Phemeranthus parviflorus	Nt P-FORB	Rock Pink
PHICOR	*	PHILADELPHUS CORONARIUS	Ad SHRUB	Sweet Mock Orange
PHIPUB	10	Philadelphus pubescens var. verrucosus	Nt SHRUB	Hoary Mock Orange
PHLPRA	*	PHLEUM PRATENSE	Ad P-GRASS	Timothy
PHLAMP	9	Phlox amplifolia	Nt P-FORB	Broadleaf Phlox
PHLBIF	8	Phlox bifida	Nt P-FORB	Sand Phlox
PHLDIV	4	Phlox divaricata	Nt P-FORB	Blue Phlox
PHLDRU	*	PHLOX DRUMMONDII	Ad A-FORB	Drummond Phlox
PHLGLA	8	Phlox glaberrima subsp. interior	Nt P-FORB	Marsh Phlox
PHLMAC	10	Phlox maculata subsp. pyramidalis	Nt P-FORB	Sweet William Phlox
PHLPAN	3	Phlox paniculata	Nt P-FORB	Garden Phlox
PHLPIF†	6	Phlox pilosa subsp. fulgida	Nt P-FORB	Prairie Phlox

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
PHLPIO†	6	Phlox pilosa subsp. ozarkana	Nt P-FORB	Prairie Phlox
PHLPIP†	6	Phlox pilosa subsp. pilosa	Nt P-FORB	Prairie Phlox
PHLSUB	*	PHLOX SUBULATA	Ad P-FORB	Moss Phlox
PHOLEU	7	Phoradendron leucarpum	Nt SHRUB	Mistletoe
PHRAUM†	6	Phragmites australis subsp. americanus◀	Nt P-GRASS	American Reed
PHRAUU†	*	PHRAGMITES AUSTRALIS subsp. AUSTRALIS◀	Ad P-GRASS	Common Reed
PHRLEP	2	Phryma leptostachya	Nt P-FORB	Lopseed
PHYCAR	5	Phyllanthus carolinensis	Nt A-FORB	Carolina Leaf-Flower
PHYPOL	10	Phyllanthus polygonoides	Nt P-FORB	Knotweed Leaf-Flower
PHYLVI†	*	PHYLLOSTACHYS VIRIDIS	Ad P-GRASS	Sulphur Bamboo
PHSAAC†	*	PHYSALIS ACUTIFOLIA	Ad A-FORB	Wright's Ground Cherry
PHSAAL†	*	PHYSALIS ALKEKENGI	Ad P-FORB	Chinese Lantern Plant
PHSAAN†	3	Physalis angulata	Nt A-FORB	Cutleaf Ground Cherry
PHSACI†	*	PHYSALIS CINERASCENS	Ad P-FORB	Stellate Ground Cherry
PHYCOR	5	Physalis cordata	Nt A-FORB	Heart-Leaved Ground Cherry
PHSAGR†	6	Physalis grisea	Nt A-FORB	Strawberry Tomato
PHSAHE†	3	Physalis heterophylla	Nt P-FORB	Clammy Ground Cherry
PHSALO†	2	Physalis longifolia	Nt P-FORB	Ground Cherry
PHSAMI†	5	Physalis missouriensis	Nt A-FORB	Missouri Ground Cherry
PHSAPH†	*	PHYSALIS PHILADELPHICA	Ad A-FORB	Tomatillo
PHSAPB†	4	Physalis pubescens	Nt A-FORB	Downy Ground Cherry
PHSAPM†	6	Physalis pumila	Nt P-FORB	Prairy Ground Cherry
PHSAVI†	3	Physalis virginiana	Nt P-FORB	Lance-Leaved Ground Cherry
PHYFIL	9	Physaria filiformis	Nt A-FORB	Missouri Bladderpod
PHYGRA	*	PHYSARIA GRACILIS	Ad A-FORB	Slender Bladderpod
PHYOPU	5	Physocarpus opulifolius var. intermedius	Nt SHRUB	Ninebark
PHYANG	6	Physostegia angustifolia	Nt P-FORB	Narrow-Leaved Dragonhead
PHYINT	10	Physostegia intermedia	Nt P-FORB	Slender Dragonhead
PHYVIP†	7	Physostegia virginiana subsp. praemorsa	Nt P-FORB	False Dragonhead
PHYVIV†	5	Physostegia virginiana subsp. virginiana	Nt P-FORB	False Dragonhead
PHYAME	2	Phytolacca americana	Nt P-FORB	Pokeweed
PICHIE	*	PICRIS HIERACIOIDES	Ad A-FORB	Ox Tongue
PICRHA	*	PICRIS RHAGADIOLOIDES	Ad A-FORB	Bitter-Weed
PILPUM	4	Pilea pumila	Nt A-FORB	Clearweed
PILAME	6	Pilularia americana	Nt FERN	Pillwort
PINBAN	*	PINUS BANKSIANA	Ad TREE	Jack Pine
PINECH	5	Pinus echinata	Nt TREE	Short-Leaf Pine
PINNIG	*	PINUS NIGRA	Ad TREE	Austrian Pine

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
PINSTR	*	PINUS STROBUS	Ad TREE	Eastern White Pine
PINTAE	*	PINUS TAEDA	Ad TREE	Loblolly Pine
PINVIR	*	PINUS VIRGINIANA	Ad TREE	Scrub Pine
PISSTR	*	PISTIA STRATIOTES	Ad P-FORB	Water Lettuce
PISSAT	*	PISUM SATIVUM	Ad A-FORB	Field Pea
PLAAQU	8	Planera aquatica	Nt TREE	Water Elm
PLDVIR†	0	Planodes virginica	Nt A-FORB	Virginia Rock Cress
PLAARI	1	Plantago aristata	Nt A-FORB	Bracted Plantain
PLACOR	10	Plantago cordata	Nt P-FORB	Heart-Leaved Plantain
PLAELO	1	Plantago elongata	Nt A-FORB	Slender Plantain
PLAHET	0	Plantago heterophylla	Nt A-FORB	Small Plantain
PLAIND	*	PLANTAGO INDICA	Ad A-FORB	Whorled Plantain
PLALAN	*	PLANTAGO LANCEOLATA	Ad A-FORB	English Plantain
PLAMAJ	*	PLANTAGO MAJOR	Ad A-FORB	Common Plantain
PLAPAT	0	Plantago patagonica	Nt A-FORB	Patagonia Plantain
PLARHO	*	PLANTAGO RHODOSPERMA	Ad A-FORB	Red-Seeded Plantain
PLARUG	0	Plantago rugelii	Nt A-FORB	Red-Stalked Plantain
PLAVIG†	1	Plantago virginica	Nt A-FORB	Dwarf Plantain
PLAWRI	*	PLANTAGO WRIGHTIANA	Ad P-FORB	Wright's Plantain
PLACIL	10	Platanthera ciliaris	Nt P-FORB	Orange Fringed Orchid
PLACLA	10	Platanthera clavellata	Nt P-FORB	Small Green Fringed Orchid
PLAFLF†	10	Platanthera flava var. flava	Nt P-FORB	Pale Green Orchid
PLAFLH†	10	Platanthera flava var. herbiola	Nt P-FORB	Tubercled Orchid
PLALAC	6	Platanthera lacera	Nt P-FORB	Ragged Fringed Orchid
PLALEU	10	Platanthera leucophaea	Nt P-FORB	Eastern Prairie White Fringed Orchid
PLAPER	8	Platanthera peramoena	Nt P-FORB	Purple Fringless Orchid
PLAPRA	10	Platanthera praeclara	Nt P-FORB	Western Prairie White Fringed Orchid
PLAPSY	10	Platanthera psychodes	Nt P-FORB	Purple Fringed Orchid
PLAOCC	3	Platanus occidentalis	Nt TREE	Sycamore
PLUCAM	4	Pluchea camphorata	Nt A-FORB	Camphor Weed
PLUFOE	10	Pluchea foetida	Nt P-FORB	Stinking Marsh Fleabane
POAANN	*	POA ANNUA	Ad A-GRASS	Annual Blue Grass
POABUL	*	POA BULBOSA	Ad P-GRASS	Bulbous Blue Grass
POACHA	2	Poa chapmaniana	Nt A-GRASS	Spear Grass
POACOM	*	POA COMPRESSA	Ad P-GRASS	Canada Blue Grass
POAINT	10	Poa interior	Nt P-GRASS	Inland Bluegrass
POAPAL	*	POA PALUSTRIS	Ad P-GRASS	Marsh Blue Grass
POAPRA	*	POA PRATENSIS	Ad P-GRASS	Kentucky Blue Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
POASYL	5	Poa sylvestris	Nt P-GRASS	Woodland Blue Grass
POATRI	*	POA TRIVIALIS	Ad P-GRASS	Rough Blue Grass
POAWOL	8	Poa wolfii	Nt P-GRASS	Wolf's Blue Grass
PODPEL	4	Podophyllum peltatum	Nt P-FORB	May Apple
POGOPH	10	Pogonia ophioglossoides	Nt P-FORB	Snakemouth Orchid
POLDOC†	1	Polanisia dodecandra subsp. dodecandra	Nt A-FORB	Clammyweed
POLDOT†	4	Polanisia dodecandra subsp. trachysperma	Nt A-FORB	Rough-Seeded Clammy Weed
POLREP	6	Polemonium reptans	Nt P-FORB	Jacob's Ladder
POLINC	8	Polygala incarnata	Nt A-FORB	Pink Milkwort
POLSAN	4	Polygala sanguinea	Nt A-FORB	Field Milkwort
POLSEN	6	Polygala senega	Nt P-FORB	Seneca Snakeroot
POLVER	4	Polygala verticillata	Nt A-FORB	Whorled Milkwort
POLBIF	4	Polygonatum biflorum var. commutatum	Nt P-FORB	Smooth Solomon's Seal
POLACH	0	Polygonum achoreum	Nt A-FORB	Leathery Knotweed
POLAME	10	Polygonum americanum	Nt P-FORB	Southern Jointweed
POLAVA†	*	POLYGONUM AVICULARE subsp. AVICULARE	Ad A-FORB	Common Knotweed
POLAVB†	2	Polygonum aviculare subsp. buxiforme	Nt A-FORB	Box Knotweed
POLAVD†	*	POLYGONUM AVICULARE subsp. DEPRESSUM	Ad A-FORB	Oval-Leaf Knotweed
POLAVN†	*	POLYGONUM AVICULARE subsp. NEGLECTUM	Ad A-FORB	Narrowleaf Knotweed
POLERE	1	Polygonum erectum	Nt A-FORB	Erect Knotweed
POLRAP†	5	Polygonum ramosissimum var. prolificum ◂	Nt A-FORB	Bushy Knotweed
POLRAR†	5	Polygonum ramosissimum var. ramosissimum ◂	Nt A-FORB	Bushy Knotweed
POLTEN	6	Polygonum tenue	Nt A-FORB	Slender Knotweed
POLCAN	6	Polymnia canadensis	Nt P-FORB	Leafcup
POLLAE	10	Polymnia laevigata	Nt P-FORB	Smooth Leaf Cup
POLPOL	8	Polypodium polypodioides var. michauxianum	Nt FERN	Resurrection Fern
POLPVI†	9	Polypodium virginianum	Nt FERN	Common Polypody
POLPRO	4	Polypremum procumbens	Nt P-FORB	Polypremum
POLACR	5	Polystichum acrostichoides	Nt FERN	Christmas Fern
POLNUT	8	Polytaenia nuttallii	Nt P-FORB	Prairie Parsley
POMJAM	*	POMARIA JAMESII	Ad P-FORB	Rush Pea
PONCOR	7	Pontederia cordata	Nt P-FORB	Pickerel Weed
POPCAD†	*	POPULUS × CANADENSIS	Ad TREE	Eugene Poplar
POPCAS†	*	POPULUS × CANESCENS	Ad TREE	European Hybrid Aspen
POPJAC	*	POPULUS × JACKII	Ad TREE	Balm-Of-Gilead
POPALB	*	POPULUS ALBA	Ad TREE	White Poplar

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
POPDEL	2	Populus deltoides	Nt TREE	Cottonwood
POPGRA	10	Populus grandidentata	Nt TREE	Large-Toothed Aspen
POPHET	9	Populus heterophylla	Nt TREE	Swamp Cottonwood
POPNIG	*	POPULUS NIGRA var. ITALICA	Ad TREE	Lombardy Poplar
POPTRE	7	Populus tremuloides	Nt TREE	Quaking Aspen
PORGRA	*	PORTULACA GRANDIFLORA	Ad A-FORB	Portulaca
PORPIL	7	Portulaca pilosa	Nt A-FORB	Shaggy Portulaca
POROLE	0	Portulacca oleracea◄	Nt A-FORB	Purslane
POTAMP	10	Potamogeton amplifolius	Nt P-FORB	Large-Leaved Pondweed
POTCRI	*	POTAMOGETON CRISPUS	Ad P-FORB	Beginner's Pondweed
POTDIV	5	Potamogeton diversifolius	Nt P-FORB	Waterthread Pondweed
POTEPI	10	Potamogeton epihydrus	Nt P-FORB	Ribbon-Leaved Pondweed
POTFOL	6	Potamogeton foliosus	Nt P-FORB	Leafy Pondweed
POTILL	8	Potamogeton illinoensis	Nt P-FORB	Illinois Pondweed
POTNOD	5	Potamogeton nodosus	Nt P-FORB	Long-Leaved Pondweed
POTPEC	7	Potamogeton pectinatus	Nt P-FORB	Comb Pondweed
POTPUL	10	Potamogeton pulcher	Nt P-FORB	Spotted Pondweed
POTPUS	8	Potamogeton pusillus	Nt P-FORB	Small Pondweed
POTARG	*	POTENTILLA ARGENTEA	Ad A-FORB	Silvery Cinquefoil
POTCAN	8	Potentilla canadensis	Nt P-FORB	Five Fingers
POTNOR	0	Potentilla norvegica	Nt A-FORB	Rough Cinquefoil
POTREC	*	POTENTILLA RECTA	Ad P-FORB	Sulphur Cinquefoil
POTRIV	4	Potentilla rivalis	Nt A-FORB	Brook Cinquefoil
POTSIM	3	Potentilla simplex◄	Nt P-FORB	Common Cinquefoil
POTSUP	8	Potentilla supina subsp. paradoxa	Nt A-FORB	River Cinquefoil
PREALB	9	Prenanthes alba	Nt P-FORB	White Lettuce
PREALT	5	Prenanthes altissima	Nt P-FORB	Tall White Lettuce
PREASP	7	Prenanthes aspera	Nt P-FORB	Rough White Lettuce
PRECRE	9	Prenanthes crepidinea	Nt P-FORB	Great White Lettuce
PRERAC	10	Prenanthes racemosa	Nt P-FORB	Glaucous White Lettuce
PRIFAS	10	Primula fassettii	Nt P-FORB	Amethyst Shooting Star
PRIFRE	10	Primula frenchii	Nt P-FORB	French's Shooting Star
PRIMEA	7	Primula meadia	Nt P-FORB	Shooting Star
PRIVER	*	PRIMULA VERIS	Ad P-FORB	Cowslip Primrose
PROLOU	*	PROBOSCIDEA LOUISIANA◄	Ad A-FORB	Unicorn Plant
PROPAL	8	Proserpinaca palustris	Nt P-FORB	Mermaid Weed
PROGLA	*	PROSOPIS GLANDULOSA	Ad SHRUB	Honey Mesquite
PRUVUA†	1	Prunella vulgaris var. lanceolata	Nt P-FORB	Self-Heal
PRUVUV†	*	PRUNELLA VULGARIS var. VULGARIS	Ad P-FORB	Lawn Prunella

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
PRUAME	4	Prunus americana	Nt TREE	Wild Plum
PRUANG	5	Prunus angustifolia	Nt SHRUB	Chickasaw Plum
PRUARM	*	PRUNUS ARMENIACA	Ad TREE	Apricot
PRUCER	*	PRUNUS CERASUS	Ad TREE	Sour Cherry
PRUHOR	3	Prunus hortulana◄	Nt TREE	Hortulan Plum
PRUMAH	*	PRUNUS MAHALEB	Ad TREE	Perfumed Cherry
PRUMEX	3	Prunus mexicana	Nt TREE	Mexican Plum
PRUMUN	5	Prunus munsoniana◄	Nt TREE	Wild Goose Plum
PRUPER	*	PRUNUS PERSICA	Ad TREE	Peach
PRUSER	2	Prunus serotina	Nt TREE	Wild Black Cherry
PRUSPI	*	PRUNUS SPINOSA	Ad SHRUB	Blackthorn
PRUVIR	4	Prunus virginiana	Nt SHRUB	Choke Cherry
PSEHEL	4	Pseudognaphalium helleri	Nt A-FORB	Rabbit Tobacco
PSEMIC	5	Pseudognaphalium micradenium	Nt A-FORB	Smooth Rabbit Tobacco
PSEOBT	2	Pseudognaphalium obtusifolium	Nt A-FORB	Old-Field Balsam
PTETRI	5	Ptelea trifoliata	Nt SHRUB	Hop Tree
PTEAQU	4	Pteridium aquilinum	Nt FERN	Bracken Fern
PTICAP	10	Ptilimnium capillaceum	Nt A-FORB	Mock Bishop's Weed
PTICOS	7	Ptilimnium costatum	Nt A-FORB	Ribbed Mock Bishop's Weed
PTINUT	4	Ptilimnium nuttallii	Nt A-FORB	Nuttall's Mock Bishop's Weed
PUCDIS	*	PUCCINELLIA DISTANS	Ad P-GRASS	Alkali Grass
PUEMON	*	PUERARIA MONTANA var. LOBATA	Ad W-VINE	Kudzu Vine
PYCALB	7	Pycnanthemum albescens	Nt P-FORB	White Mountain Mint
PYCMUT	10	Pycnanthemum muticum	Nt P-FORB	Short-Toothed Mountain Mint
PYCPIL	5	Pycnanthemum pilosum	Nt P-FORB	Hairy Mountain Mint
PYCTEN	4	Pycnanthemum tenuifolium	Nt P-FORB	Slender Mountain Mint
PYCTOR	10	Pycnanthemum torrei	Nt P-FORB	Torrey's Mountain Mint
PYCVIR	6	Pycnanthemum virginianum	Nt P-FORB	Common Mountain Mint
PYRCOC	*	PYRACANTHA COCCINEA	Ad SHRUB	Firethorn
PYRCAR	0	Pyrrhopappus carolinianus	Nt A-FORB	Yellow False Dandelion
PYRCAL	*	PYRUS CALLERYANA	Ad TREE	Bradford Pear
PYRCOM	*	PYRUS COMMUNIS	Ad TREE	Pear
QUEACU	*	QUERCUS ACUTISSIMA	Ad TREE	Sawtooth Oak
QUEALB	4	Quercus alba	Nt TREE	White Oak
QUEBIC	7	Quercus bicolor	Nt TREE	Swamp White Oak
QUECOC	5	Quercus coccinea	Nt TREE	Scarlet Oak
QUEELL	10	Quercus ellipsoidalis	Nt TREE	Hill's Oak
QUEFAL	6	Quercus falcata	Nt TREE	Southern Red Oak

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
QUEIMB	3	Quercus imbricaria	Nt TREE	Shingle Oak
QUELYR	8	Quercus lyrata	Nt TREE	Overcup Oak
QUEMAC	4	Quercus macrocarpa	Nt TREE	Bur Oak
QUEMAR	4	Quercus marilandica	Nt TREE	Blackjack Oak
QUEMIC	9	Quercus michauxii	Nt TREE	Basket Oak
QUEMUE	5	Quercus muehlenbergii	Nt TREE	Chinquapin Oak
QUENIG	5	Quercus nigra	Nt TREE	Water Oak
QUEPAG	7	Quercus pagoda	Nt TREE	Cherrybark Oak
QUEPAL	4	Quercus palustris	Nt TREE	Pin Oak
QUEPHE	7	Quercus phellos	Nt TREE	Willow Oak
QUEPRI	5	Quercus prinoides	Nt TREE	Dwarf Chestnut Oak
QUERUB	5	Quercus rubra◀	Nt TREE	Red Oak
QUESHA†	7	Quercus shumardii var. acerifolia◀	Nt TREE	Schneck Oak
QUESHS†	5	Quercus shumardii var. shumardii	Nt TREE	Shumard Oak
QUESIM	9	Quercus similis	Nt TREE	Bottomland Post Oaki
QUESTE	4	Quercus stellata	Nt TREE	Post Oak
QUETEX	10	Quercus texana	Nt TREE	Nuttall's Oak
QUEVEL	4	Quercus velutina	Nt TREE	Black Oak
RANABO	1	Ranunculus abortivus	Nt P-FORB	Small-Flowered Buttercup
RANACR	*	RANUNCULUS ACRIS	Ad P-FORB	Tall Buttercup
RANAQU	8	Ranunculus aquatilis var. diffusus	Nt P-FORB	White Crowfoot
RANARV	*	RANUNCULUS ARVENSIS	Ad A-FORB	Spiny Buttercup
RANBUL	*	RANUNCULUS BULBOSUS	Ad P-FORB	Bulbous Buttercup
RANCYM	10	Ranunculus cymbalaria	Nt P-FORB	Seaside Crowfoot
RANFAS	5	Ranunculus fascicularis	Nt P-FORB	Early Buttercup
RANFIC	*	RANUNCULUS FICARIA	Ad P-FORB	Lesser Celandine
RANFLA	8	Ranunculus flabellaris	Nt P-FORB	Yellow Water Crowfoot
RANHAR	7	Ranunculus harveyi	Nt P-FORB	Harvey's Buttercup
RANHIC†	4	Ranunculus hispidus var. caricetorum	Nt P-FORB	Swamp Buttercup
RANHIH†	6	Ranunculus hispidus var. hispidus	Nt P-FORB	Hispid Buttercup
RANHIN†	4	Ranunculus hispidus var. nitidus	Nt P-FORB	Swamp Buttercup
RANLAX	7	Ranunculus laxicaulis	Nt A-FORB	Water Plantain Spearwort
RANMIC	3	Ranunculus micranthus	Nt P-FORB	Rock Crowfoot
RANPAR	*	RANUNCULUS PARVIFLORUS	Ad A-FORB	Small-Flowered Crowfoot
RANPUS	6	Ranunculus pusillus	Nt A-FORB	Low Spearwort
RANREC	5	Ranunculus recurvatus	Nt P-FORB	Hooked Buttercup
RANREP	*	RANUNCULUS REPENS	Ad P-FORB	Creeping Buttercup
RANSAR	*	RANUNCULUS SARDOUS	Ad A-FORB	Hairy Buttercup
RANSCE	5	Ranunculus sceleratus	Nt A-FORB	Cursed Buttercup

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
RAPRAP	*	RAPHANUS RAPHANISTRUM	Ad A-FORB	Wild Radish
RAPSAT	*	RAPHANUS SATIVUS	Ad A-FORB	Radish
RAPRUG	*	RAPISTRUM RUGOSUM	Ad A-FORB	Turnipweed
RATCOL	*	RATIBIDA COLUMNIFERA	Ad P-FORB	Long-Headed Coneflower
RATPIN	4	Ratibida pinnata	Nt P-FORB	Grey-Headed Coneflower
RATTAG	*	RATIBIDA TAGETES	Ad P-FORB	Shortray Prairie Coneflower
RESLUA†	*	RESEDA LUTEA	Ad P-FORB	Wild Mignonette
RESLUO†	*	RESEDA LUTEOLA	Ad B-FORB	Dyer's Rocket
RHACAR	6	Rhamnus caroliniana	Nt SHRUB	Carolina Buckthorn
RHACAT	*	RHAMNUS CATHARTICA	Ad SHRUB	Common Buckthorn
RHADAV	*	RHAMNUS DAVURICA	Ad SHRUB	Dahurian Buckthorn
RHAJAP	*	RHAMNUS JAPONICA	Ad SHRUB	Japanese Buckthorn
RHALAN	5	Rhamnus lanceolata	Nt SHRUB	Lance-Leaved Buckthorn
RHEMAI†	9	Rhexia mariana var. interior	Nt P-FORB	Meadow Beauty
RHEMAM†	8	Rhexia mariana var. mariana	Nt P-FORB	Maryland Meadow Beauty
RHEVIR	6	Rhexia virginica	Nt P-FORB	Virginia Meadow Beauty
RHOPRI	8	Rhododendron prinophyllum	Nt SHRUB	Azalea
RHOSCA	*	RHODOTYPOS SCANDENS	Ad SHRUB	Jetbead
RHUARA†	4	Rhus aromatica var. aromatica	Nt SHRUB	Common Fragrant Sumac
RHUARS†	6	Rhus aromatica var. serotina	Nt SHRUB	Tall Frangrant Sumac
RHUCOP	2	Rhus copallinum var. latifolia	Nt SHRUB	Shining Sumac
RHUGLA	1	Rhus glabra	Nt SHRUB	Smooth Sumac
RHUTYP	*	RHUS TYPHINA	Ad SHRUB	Staghorn Sumac
RHYDIF	10	Rhynchosia difformis	Nt P-FORB	Double-Formed Snoutbean
RHYLAT	9	Rhynchosia latifolia	Nt P-FORB	Prairie Snoutbean
RHYCAC†	10	Rhynchospora capillacea	Nt P-SEDGE	Hair Beak Rush
RHYCAT†	8	Rhynchospora capitellata	Nt P-SEDGE	Clustered Beak Rush
RHYCOR	7	Rhynchospora corniculata	Nt P-SEDGE	Shortbristle Horned Rush
RHYGLO	8	Rhynchospora globularis var. recognita	Nt P-SEDGE	Grass Beak Rush
RHYHAR	10	Rhynchospora harveyi	Nt P-SEDGE	Harvey's Beak Rush
RHYMAC	9	Rhynchospora macrostachya	Nt P-SEDGE	Tall Horned Rush
RHYSCI	10	Rhynchospora scirpoides◄	Nt A-SEDGE	Long-Beaked Beak Rush
RIBAME	10	Ribes americanum	Nt SHRUB	Wild Black Current
RIBCYN	5	Ribes cynosbati	Nt SHRUB	Prickly Wild Gooseberry
RIBMIS	3	Ribes missouriense	Nt SHRUB	Wild Gooseberry
RIBODO	10	Ribes odoratum	Nt SHRUB	Clove Current
RICCOM	*	RICINUS COMMUNIS	Ad A-FORB	Castor-Oil Plant
ROBHIS	*	ROBINIA HISPIDA	Ad SHRUB	Bristly Locust
ROBPSI†	*	ROBINIA PSEUDOACACIA◄	Ad TREE	Black Locust (introduced)

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
ROBPSN†	6	Robinia pseudoacacia◀	Nt TREE	Black Locust (native)
RORAQU	10	Rorippa aquatica	Nt P-FORB	Lake Cress
RORCUR	5	Rorippa curvipes	Nt A-FORB	Blunt-Leaved Yellow Cress
RORPAL	2	Rorippa palustris var. fernaldiana	Nt A-FORB	Marsh Yellow Cress
RORSES	3	Rorippa sessiliflora	Nt A-FORB	Sessile-Flowered Cress
RORSIN	3	Rorippa sinuata	Nt P-FORB	Spreading Yellow Cress
RORSYL	*	RORIPPA SYLVESTRIS	Ad P-FORB	Creeping Yellow Cress
RORTEN	5	Rorippa tenerrima	Nt A-FORB	Modoc Yellow Cress
ROSARK	5	Rosa arkansana	Nt SHRUB	Sunshine Rose
ROSBLA	6	Rosa blanda	Nt SHRUB	Early Wild Rose
ROSCAN	*	ROSA CANINA	Ad SHRUB	Dog Rose
ROSCAC†	4	Rosa carolina subsp. carolina◀	Nt SHRUB	Pasture Rose
ROSCAS†	4	Rosa carolina subsp. subserrulata◀	Nt SHRUB	Pasture Rose
ROSGAL	*	ROSA GALLICA	Ad SHRUB	French Rose
ROSLUC	*	ROSA LUCIEAE	Ad SHRUB	Memorial Rose
ROSMUL	*	ROSA MULTIFLORA	Ad SHRUB	Multiflora Rose
ROSPAL	7	Rosa palustris	Nt SHRUB	Swamp Rose
ROSRUB	*	ROSA RUBIGINOSA	Ad SHRUB	Sweetbriar
ROSRUG	*	ROSA RUGOSA	Ad SHRUB	Rugosa Rose
ROSSET	4	Rosa setigera	Nt SHRUB	Prairie Rose
ROSSPI	*	ROSA SPINOSISSIMA	Ad SHRUB	Scotch Rose
ROSWOO	*	ROSA WOODSII	Ad SHRUB	Woods Rose
ROTRAM	4	Rotala ramosior	Nt A-FORB	Toothcup
RUBABL	2	Rubus ablatus◀	Nt SHRUB	Plains Blackberry
RUBABO	4	Rubus aboriginum	Nt SHRUB	Garden Dewberry
RUBALL	4	Rubus allegheniensis	Nt SHRUB	Common Blackberry
RUBALU	4	Rubus alumnus◀	Nt SHRUB	Old Field Blackberry
RUBARG	1	Rubus argutus◀	Nt SHRUB	Sawtooth Blackberry
RUBARM	*	RUBUS ARMENIACUS	Ad SHRUB	Himalayan Blackberry
RUBCEL	4	Rubus celer◀	Nt SHRUB	Bountiful Dewberry
RUBCUR	3	Rubus curtipes◀	Nt SHRUB	Short-Stalked Dewberry
RUBDEA	4	Rubus deamii	Nt SHRUB	Deam's Dewberry
RUBENS	5	Rubus enslenii◀	Nt SHRUB	One-Flowered Dewberry
RUBFLA	3	Rubus flagellaris◀	Nt SHRUB	Common Dewberry
RUBFRO	2	Rubus frondosus◀	Nt SHRUB	Yankee Blackberry
RUBIDA	*	RUBUS IDAEUS var. STRIGOSUS	Ad SHRUB	Red Raspberry
RUBLAC	*	RUBUS LACINIATUS	Ad SHRUB	Cutleaf Blackberry
RUBLAU	4	Rubus laudatus◀	Nt SHRUB	Paririe Blackberry
RUBLEV	4	Rubus leviculus	Nt SHRUB	Bottomland Dewberry

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
RUBMER	6	Rubus meracus◀	Nt SHRUB	Dryslope Dewberry
RUBMIS	7	Rubus missouricus◀	Nt SHRUB	Missouri Dewberry
RUBMOL	5	Rubus mollior◀	Nt SHRUB	Softleaf Blackberry
RUBOCC	3	Rubus occidentalis	Nt SHRUB	Black Raspberry
RUBPAR	*	RUBUS PARVIFOLIUS	Ad SHRUB	Small-Leaved Raspberry
RUBPHO	*	RUBUS PHOENICOLASIUS	Ad SHRUB	Wineberry
RUBPLI	6	Rubus plicatifolius◀	Nt SHRUB	Pleat-Leaved Dewberry
RUBROR	6	Rubus roribaccus◀	Nt SHRUB	Lucretia Dewberry
RUBROS	3	Rubus rosa	Nt SHRUB	Rose Blackberry
RUBSAT	4	Rubus satis◀	Nt SHRUB	New York Dewberry
RUBSER	*	RUBUS SERISSIMUS	Ad SHRUB	Chesapeake Blackberry
RUBSTE	3	Rubus steelei	Nt SHRUB	Steele's Dewberry
RUBTRI	4	Rubus trivialis	Nt SHRUB	Southern Dewberry
RUDAMP	3	Rudbeckia amplexicaulis	Nt A-FORB	Coneflower
RUDBIC	2	Rudbeckia bicolor◀	Nt A-FORB	Pine Woods Coneflower
RUDFUS†	7	Rudbeckia fulgida var. sullivantii◀	Nt P-FORB	Orange Coneflower
RUDFUU†	7	Rudbeckia fulgida var. umbrosa◀	Nt P-FORB	Orange Coneflower
RUDGRA	*	RUDBECKIA GRANDIFLORA	Ad P-FORB	Large Black-Eyed Susan
RUDHIR	1	Rudbeckia hirta◀	Nt P-FORB	Black-Eyed Susan
RUDLAC	4	Rudbeckia laciniata	Nt P-FORB	Wild Golden Glow
RUDMAX	*	RUDBECKIA MAXIMA	Ad P-FORB	Great Coneflower
RUDMIS	6	Rudbeckia missouriensis	Nt P-FORB	Missouri Black-Eyed Susan
RUDSUB	5	Rudbeckia subtomentosa	Nt P-FORB	Sweet Black-Eyed Susan
RUDTRI	3	Rudbeckia triloba	Nt B-FORB	Brown-Eyed Susan
RUEHUM	3	Ruellia humilis	Nt P-FORB	Hairy Ruellia
RUEPED	5	Ruellia pedunculata	Nt P-FORB	Wild Petunia
RUESTR	3	Ruellia strepens	Nt P-FORB	Smooth Ruellia
RUMACE	*	RUMEX ACETOSELLA	Ad P-FORB	Field Sorrel
RUMALT	2	Rumex altissimus	Nt P-FORB	Pale Dock
RUMCON	*	RUMEX CONGLOMERATUS	Ad P-FORB	Clustered Dock
RUMCRP†	*	RUMEX CRISPUS	Ad P-FORB	Curly Dock
RUMCRT†	*	RUMEX CRISTATUS	Ad P-FORB	Greek Dock
RUMDEN	*	RUMEX DENTATUS	Ad P-FORB	Asian Dock
RUMFUE	5	Rumex fueginus	Nt A-FORB	Golden Dock
RUMHAS	3	Rumex hastatulus	Nt P-FORB	Wild Sorrel
RUMOBT	*	RUMEX OBTUSIFOLIUS	Ad P-FORB	Bitter Dock
RUMPAT	*	RUMEX PATIENTIA	Ad P-FORB	Patience Dock
RUMPUL	*	RUMEX PULCHER	Ad P-FORB	Fiddle Dock
RUMSTE	*	RUMEX STENOPHYLLUS	Ad P-FORB	Eurasian Dock

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
RUMTRI	3	Rumex triangulivalvis	Nt P-FORB	Mexican Dock
RUMVER	7	Rumex verticillatus	Nt P-FORB	Swamp Dock
RUPMAR	10	Ruppia maritima	Nt P-FORB	Ditch Grass
RUTGRA	*	RUTA GRAVEOLENS	Ad SHRUB	Common Rue
SABANG	4	Sabatia angularis	Nt B-FORB	Rose Gentian
SABBRA	10	Sabatia brachiata	Nt B-FORB	Narrow-Leaved Marsh Pink
SABCAM	4	Sabatia campestris	Nt B-FORB	Prairie Rose Gentian
SACSTR	9	Sacciolepis striata	Nt P-GRASS	Cupscale
SAGDEC	2	Sagina decumbens	Nt A-FORB	Trailing Pearlwort
SAGPRO	*	SAGINA PROCUMBENS	Ad P-FORB	Birdeye Pearlwort
SAGAMB	10	Sagittaria ambigua	Nt P-FORB	Kansas Arrowhead
SAGBRE	5	Sagittaria brevirostra	Nt P-FORB	Engelmann's Arrowhead
SAGCAL	4	Sagittaria calycina	Nt A-FORB	Long-Lobed Arrowhead
SAGGRA	6	Sagittaria graminea	Nt P-FORB	Grass-Leaved Arrowhead
SAGLAT	4	Sagittaria latifolia	Nt P-FORB	Common Arrowhead
SAGPLA	7	Sagittaria platyphylla	Nt P-FORB	Delta Arrowhead
SAGRIG	6	Sagittaria rigida	Nt P-FORB	Stiff Arrowhead
SALEUR	*	SALICORNIA EUROPAEA	Ad A-FORB	Glasswort
SALFRA	*	SALIX × FRAGILIS	Ad TREE	Crack Willow
SALSEP	*	SALIX × SEPULCRALIS	Ad TREE	Weeping Willow
SALALB	*	SALIX ALBA	Ad TREE	White Willow
SALAMY	5	Salix amygdaloides	Nt TREE	Peach-Leaved Willow
SALCAR	4	Salix caroliniana	Nt TREE	Ward's Willow
SALDIS	10	Salix discolor	Nt SHRUB	Pussy Willow
SALERI	5	Salix eriocephala	Nt TREE	Diamond Willow
SALFAM	8	Salix famelica	Nt SHRUB	Yellow Willow
SALHUM	7	Salix humilis	Nt SHRUB	Prairie Willow
SALINT	3	Salix interior	Nt SHRUB	Sandbar Willow
SALNIG	2	Salix nigra	Nt TREE	Black Willow
SALPET	9	Salix petiolaris	Nt SHRUB	Petioled Willow
SALPUR	*	SALIX PURPUREA	Ad SHRUB	Purple Willow
SALSER	9	Salix sericea	Nt SHRUB	Autumn Willow
SALCOL	*	SALSOLA COLLINA	Ad A-FORB	Slender Russian Thistle
SALTRA	*	SALSOLA TRAGUS	Ad A-FORB	Russian Thistle
SALAZU	4	Salvia azurea var. grandiflora	Nt P-FORB	Blue Sage
SALCOC	*	SALVIA COCCINEA	Ad A-FORB	Scarlet Sage
SALLYR	3	Salvia lyrata	Nt P-FORB	Lyre-Leaved Sage
SALREF	3	Salvia reflexa	Nt A-FORB	Rocky Mountain Sage
SAMCAN	2	Sambucus canadensis	Nt SHRUB	Elderberry

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
SAMPUB	10	Sambucus pubens	Nt SHRUB	Red-Berried Elder
SAMPAR	5	Samolus parviflorus	Nt P-FORB	Water Pimpernel
SANGCA†	5	Sanguinaria canadensis	Nt P-FORB	Bloodroot
SANICA†	3	Sanicula canadensis	Nt B-FORB	Canadian Black Snakeroot
SANODO	2	Sanicula odorata	Nt P-FORB	Clustered Black Snakeroot
SANSMA	10	Sanicula smallii	Nt P-FORB	Small's Black Snakeroot
SAPSAP	10	Sapindus saponaria var. drummondii	Nt TREE	Soapberry
SAPOFF	*	SAPONARIA OFFICINALIS	Ad P-FORB	Bouncing Bet
SASALB	2	Sassafras albidum	Nt TREE	Sassafras
SAUCER	6	Saururus cernuus	Nt P-FORB	Lizard's Tail
SCAATR	*	SCABIOSA ATROPURPUREA	Ad P-FORB	Pincushions
SCHPAN	3	Schedonnardus paniculatus	Nt P-GRASS	Tumble Grass
SCHSCO	5	Schizachyrium scoparium◄	Nt P-GRASS	Little Bluestem
SCHACU	7	Schoenoplectus acutus	Nt P-SEDGE	Hard-Stemmed Bulrush
SCHAME	10	Schoenoplectus americanus	Nt P-SEDGE	Saltmarsh Bulrush
SCHCAL	*	SCHOENOPLECTUS CALIFORNICUS	Ad P-SEDGE	California Bulrush
SCHDEL	10	Schoenoplectus deltarum	Nt P-SEDGE	Delta Bulrush
SCHETU	10	Schoenoplectus etuberculatus	Nt P-SEDGE	Canby's Bulrush
SCHHAL	10	Schoenoplectus hallii	Nt A-SEDGE	Hall's Bulrush
SCHHET	7	Schoenoplectus heterochaetus	Nt P-SEDGE	Slender Bulrush
SCHMUC	*	SCHOENOPLECTUS MUCRONATUS	Ad A-SEDGE	Bog Bulrush
SCHPUN	6	Schoenoplectus pungens	Nt P-SEDGE	Chairmaker's Rush
SCHPUR	*	SCHOENOPLECTUS PURSHIANUS	Ad A-SEDGE	Weak-Stalked Bulrush
SCHSAX	9	Schoenoplectus saximontanus	Nt A-SEDGE	Rocky Mountain Bulrush
SCHSUB	10	Schoenoplectus subterminalis	Nt P-SEDGE	Swaying Bulrush
SCHTAB	5	Schoenoplectus tabernaemontani	Nt P-SEDGE	Great Bulrush
SCHTOR	10	Schoenoplectus torreyi	Nt P-SEDGE	Torrey's Bulrush
SCISIB	*	SCILLA SIBERICA	Ad P-FORB	Siberian Squill
SCIATR	3	Scirpus atrovirens	Nt P-SEDGE	Dark Green Rush
SCICYP	5	Scirpus cyperinus	Nt P-SEDGE	Wool Grass
SCIDIV	8	Scirpus divaricatus	Nt P-SEDGE	Spreading Bulrush
SCIGEO	3	Scirpus georgianus	Nt P-SEDGE	Georgia Bulrush
SCIPAL	10	Scirpus pallidus	Nt P-SEDGE	Cloaked Bulrush
SCIPED	10	Scirpus pedicellatus	Nt P-SEDGE	Stalked Bulrush
SCIPEN	5	Scirpus pendulus	Nt P-SEDGE	Red Bulrush
SCIPOL	10	Scirpus polyphyllus	Nt P-SEDGE	Leafy Bulrush
SCIRUB	5	Scirpus rubricosus◄	Nt P-SEDGE	Long-Stalked Wool Grass
SCLANN	*	SCLERANTHUS ANNUUS	Ad A-FORB	Knawel
SCLCIL	8	Scleria ciliata	Nt P-SEDGE	Hairy Nut-Rush

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
SCLOLI	8	Scleria oligantha	Nt P-SEDGE	Few-Flowered Nut-Rush
SCLPAU	6	Scleria pauciflora	Nt P-SEDGE	Papillose Nut Rush
SCLRET	10	Scleria reticularis var. pubescens	Nt A-SEDGE	Muhlenberg's Nut-Rush
SCLTRI	6	Scleria triglomerata	Nt P-SEDGE	Tall Nut Rush
SCLVER	10	Scleria verticillata	Nt A-SEDGE	Low Nut Rush
SCLDUR	*	SCLEROCHLOA DURA	Ad P-GRASS	Hard Grass
SCRLAN	10	Scrophularia lanceolata	Nt P-FORB	Early Figowrt
SCRMAR	3	Scrophularia marilandica	Nt P-FORB	Late Figwort
SCUBUS	10	Scutellaria bushii	Nt P-FORB	Bush's Skullcap
SCUELL	7	Scutellaria elliptica	Nt P-FORB	Hairy Skullcap
SCUGAL	10	Scutellaria galericulata	Nt P-FORB	Marsh Skullcap
SCUINC	5	Scutellaria incana	Nt P-FORB	Downy Skullcap
SCULAT	5	Scutellaria lateriflora	Nt P-FORB	Mad-Dog Skullcap
SCUNER	8	Scutellaria nervosa	Nt P-FORB	Veiny Skullcap
SCUOVA	5	Scutellaria ovata	Nt P-FORB	Heart-Leaved Skullcap
SCUPAA†	5	Scutellaria parvula var. australis	Nt P-FORB	Southern Small Skullcap
SCUPAM†	4	Scutellaria parvula var. missouriensis	Nt P-FORB	Leonard's Skullcap
SCUPAP†	4	Scutellaria parvula var. parvula	Nt P-FORB	Small Skullcap
SECCER	*	SECALE CEREALE	Ad A-GRASS	Rye
SECVAR	*	SECURIGERA VARIA	Ad P-FORB	Crown Vetch
SEDACR	*	SEDUM ACRE	Ad P-FORB	Mossy Stonecrop
SEDERY	*	SEDUM ERYTHROSTICTUM	Ad P-FORB	Pale-Flowered Stonecrop
SEDNUT	10	Sedum nuttallianum	Nt P-FORB	Yellow Stonecrop
SEDPUL	7	Sedum pulchellum	Nt A-FORB	Widow's Cross
SEDPUR	*	SEDUM PURPUREUM	Ad P-FORB	Live-Forever
SEDREF	*	SEDUM REFLEXUM	Ad P-FORB	Jenny's Stonecrop
SEDSAR	*	SEDUM SARMENTOSUM	Ad P-FORB	Stringy Stonecrop
SEDTER	6	Sedum ternatum	Nt P-FORB	Wild Stonecrop
SELAPO	8	Selaginella apoda	Nt FERN	Marsh Spikemoss
SELECL	8	Selaginella eclipes	Nt FERN	Hidden Spikemoss
SELRUP	8	Selaginella rupestris	Nt FERN	Sand Spikemoss
SELAUR	6	Selenia aurea	Nt A-FORB	Golden Selenia
SENAMP	*	SENECIO AMPULLACEUS	Ad A-FORB	Texas Ragwort
SENVUL	*	SENECIO VULGARIS	Ad A-FORB	Common Groundsel
SENMAR	4	Senna marilandica	Nt P-FORB	Maryland Senna
SENOBT	3	Senna obtusifolia	Nt A-FORB	Sickle Senna
SENOCC	*	SENNA OCCIDENTALIS	Ad A-FORB	Coffee Senna
SESIND	*	SESAMUM INDICUM	Ad A-FORB	Sesame
SESHER	3	Sesbania herbacea	Nt A-FORB	Sesbania

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
SESVES	*	SESBANIA VESICARIA	Ad A-FORB	Bagpod
SETFAB	*	SETARIA FABERI	Ad A-GRASS	Giant Foxtail
SETGLA	*	SETARIA GLAUCA	Ad A-GRASS	Yellow Foxtail
SETITA	*	SETARIA ITALICA	Ad A-GRASS	Foxtail Millet
SETPAR	4	Setaria parviflora	Nt P-GRASS	Perennial Foxtail
SETVER	*	SETARIA VERTICILLATA	Ad A-GRASS	Bristly Foxtail
SETVIM†	*	SETARIA VIRIDIS var. MAJOR	Ad A-GRASS	Giant Green Foxtail
SETVIV†	*	SETARIA VIRIDIS var. VIRIDIS	Ad A-GRASS	Green Foxtail
SHEARV	*	SHERARDIA ARVENSIS	Ad A-FORB	Field Madder
SICANG	4	Sicyos angulatus	Nt A-FORB	Bur Cucumber
SIDELL	10	Sida elliottii	Nt P-FORB	Elliott's Sida
SIDSPI	*	SIDA SPINOSA	Ad A-FORB	Prickly Sida
SIDLAN	5	Sideroxylon lanuginosum subsp. oblongifolium	Nt TREE	Gum Bumelia
SIDLYC	10	Sideroxylon lycioides	Nt SHRUB	Southern Buckthorn
SILANT	2	Silene antirrhina	Nt A-FORB	Sleepy Catchfly
SILCAR	9	Silene caroliniana var. wherryi	Nt P-FORB	Wild Pink
SILCON	*	SILENE CONOIDEA	Ad A-FORB	Mediterranean Catchfly
SILCSE	*	SILENE CSEREII	Ad B-FORB	Glaucous Campion
SILDIC	*	SILENE DICHOTOMA	Ad A-FORB	Forked Catchfly
SILDIO	*	SILENE DIOICA	Ad B-FORB	Red Campion
SILGAL	*	SILENE GALLICA	Ad A-FORB	French Silene
SILLAT	*	SILENE LATIFOLIA	Ad B-FORB	White Campion
SILNIV	8	Silene nivea	Nt P-FORB	Snowy Campion
SILNOC	*	SILENE NOCTIFLORA	Ad A-FORB	Night-Flowering Catchfly
SILREG	9	Silene regia	Nt P-FORB	Royal Catchfly
SILSTE	5	Silene stellata	Nt P-FORB	Starry Campion
SILVIR	7	Silene virginica	Nt P-FORB	Fire Pink
SILVUL	*	SILENE VULGARIS	Ad P-FORB	Bladder Campion
SILAST	7	Silphium asteriscus	Nt P-FORB	Starry Rosinweed
SILINI†	4	Silphium integrifolium var. integrifolium	Nt P-FORB	Rosinweed
SILINL†	4	Silphium integrifolium var. laeve	Nt P-FORB	Blue Rosinweed
SILLAC	6	Silphium laciniatum	Nt P-FORB	Compass Plant
SILPER	3	Silphium perfoliatum	Nt P-FORB	Cup Plant
SILRAD	*	SILPHIUM RADULA	Ad P-FORB	Rough-Leaved Rosinweed
SILTER	5	Silphium terebinthinaceum	Nt P-FORB	Prairie Dock
SILMAR	*	SILYBUM MARIANUM	Ad A-FORB	Milk Thistle
SINALB	*	SINAPIS ALBA	Ad A-FORB	White Mustard
SINARV	*	SINAPIS ARVENSIS	Ad A-FORB	Charlock
SISALT	*	SISYMBRIUM ALTISSIMUM	Ad A-FORB	Tumble Mustard

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
SISLOE	*	SISYMBRIUM LOESELII	Ad A-FORB	Tall Hedge Mustard
SISOFF	*	SISYMBRIUM OFFICINALE	Ad A-FORB	Hedge Mustard
SISALB	7	Sisyrinchium albidum	Nt P-FORB	Common Blue-eyed Grass
SISANG	5	Sisyrinchium angustifolium	Nt P-FORB	Pointed Blue-Eyed Grass
SISATL	9	Sisyrinchium atlanticum	Nt P-FORB	Eastern Blue-Eyed Grass
SISCAM	5	Sisyrinchium campestre	Nt P-FORB	Prairie Blue-Eyed Grass
SIUSUA	6	Sium suave	Nt P-FORB	Water Parsnip
SMAUVE	8	Smallanthus uvedalius	Nt P-FORB	Yellow-Flower Leafcup
SMIBON	3	Smilax bona-nox	Nt W-VINE	Saw Greenbriar
SMIECI	5	Smilax ecirrhata	Nt P-FORB	Upright Carrrion Flower
SMIGLA	4	Smilax glauca	Nt W-VINE	Cat Greenbriar
SMIHIS	3	Smilax hispida	Nt W-VINE	Bristly Greenbriar
SMIILL	9	Smilax illinoensis	Nt P-FORB	Illinois Carrion Flower
SMILAS	5	Smilax lasioneuron	Nt P-FORB	Carrion Flower
SMIPUL	6	Smilax pulverulenta	Nt P-FORB	Powdery Carrion Flower
SMIROT	6	Smilax rotundifolia	Nt W-VINE	Horsebriar
SOLAME	1	Solanum americanum	Nt A-FORB	American Black Nightshade
SOLCAR	0	Solanum carolinense	Nt P-FORB	Horse Nettle
SOLDIM	*	SOLANUM DIMIDIATUM	Ad P-FORB	Western Horse Nettle
SOLDUL	*	SOLANUM DULCAMARA	Ad W-VINE	Bittersweet Nightshade
SOLELA	1	Solanum elaeagnifolium	Nt P-FORB	White Horse Nettle
SOLLYC	*	SOLANUM LYCOPERSICUM	Ad A-FORB	Tomato
SOLNIG	*	SOLANUM NIGRUM	Ad A-FORB	Black Nightshade
SOLPSE	*	SOLANUM PSEUDOCAPSICUM	Ad SHRUB	Jerusalem Cherry
SOLPTY	1	Solanum ptycanthum	Nt A-FORB	West Indian Nightshade
SOLROS	*	SOLANUM ROSTRATUM	Ad A-FORB	Buffalo Bur
SOLSAR	*	SOLANUM SARACHOIDES	Ad P-FORB	Viscid Nightshade
SOLTRI	*	SOLANUM TRIFLORUM	Ad A-FORB	Cutleaf Nightshade
SOLTUB	*	SOLANUM TUBEROSUM	Ad P-FORB	Potato
SOLALA†	1	Solidago altissima var. altissima◂	Nt P-FORB	Tall Goldenrod
SOLALG†	3	Solidago altissima var. gilvicanescens◂	Nt P-FORB	Tall Goldenrod
SOLARG	7	Solidago arguta	Nt P-FORB	Sharp-Leaved Goldenrod
SOLBUC	8	Solidago buckleyi	Nt P-FORB	Buckley's Goldenrod
SOLCAE	7	Solidago caesia	Nt P-FORB	Blue-Stemmed Goldenrod
SOLCAN	1	Solidago canadensis var. hargeri◂	Nt P-FORB	Canada Goldenrod
SOLDRU	8	Solidago drummondii	Nt P-FORB	Drummond's Goldenrod
SOLFLE	7	Solidago flexicaulis	Nt P-FORB	Broad-Leaved Goldenrod
SOLGAT	10	Solidago gattingeri	Nt P-FORB	Gattinger's Goldenrod
SOLGIG	3	Solidago gigantea	Nt P-FORB	Late Goldenrod

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
SOLHIS	6	Solidago hispida	Nt P-FORB	White Goldenrod
SOLJUN	4	Solidago juncea	Nt P-FORB	Early Goldenrod
SOLMIS	6	Solidago missouriensis subsp. fasciculata	Nt P-FORB	Missouri Goldenrod
SOLNEL†	2	Solidago nemoralis var. longipetiolata◀	Nt P-FORB	Old-Field Goldenrod
SOLNEN†	2	Solidago nemoralis var. nemoralis◀	Nt P-FORB	Old-Field Goldenrod
SOLODO	8	Solidago odora	Nt P-FORB	Sweet Goldenrod
SOLPAT	10	Solidago patula	Nt P-FORB	Swamp Goldenrod
SOLPET	8	Solidago petiolaris	Nt P-FORB	Downy Goldenrod
SOLRAD	6	Solidago radula	Nt P-FORB	Rough Goldenrod
SOLRUG	6	Solidago rugosa	Nt P-FORB	Rough-Leaved Goldenrod
SOLSPR†	7	Solidago speciosa var. rigidiuscula◀	Nt P-FORB	Showy Goldenrod
SOLSPS†	7	Solidago speciosa var. speciosa	Nt P-FORB	Showy Goldenrod
SOLULM	4	Solidago ulmifolia	Nt P-FORB	Elm-Leaved Goldenrod
SONARA†	*	SONCHUS ARVENSIS subsp. ARVENSIS	Ad P-FORB	Field Sow Thistle
SONARU†	*	SONCHUS ARVENSIS subsp. ULIGINOSUS	Ad P-FORB	Common Sow Thistle
SONASP	*	SONCHUS ASPER	Ad A-FORB	Spiny Sow Thistle
SONOLE	*	SONCHUS OLERACEUS	Ad A-FORB	Store-Front Sow Thistle
SORNUT	4	Sorghastrum nutans	Nt P-GRASS	Indian Grass
SORBIC	*	SORGHUM BICOLOR	Ad A-GRASS	Sorghum
SORHAL	*	SORGHUM HALEPENSE	Ad P-GRASS	Johnson Grass
SPAAME	8	Sparganium americanum	Nt P-FORB	American Bur Reed
SPAAND	7	Sparganium androcladum	Nt P-FORB	Branching Bur Reed
SPAEUR	6	Sparganium eurycarpum	Nt P-FORB	Common Bur Reed
SPAPEC	5	Spartina pectinata	Nt P-GRASS	Prairie Cord Grass
SPEARV	*	SPERGULA ARVENSIS	Ad A-FORB	Corn Spurrey
SPESAL	*	SPERGULARIA SALINA	Ad A-FORB	Salt Spurrey
SPEGLA	5	Spermacoce glabra	Nt P-FORB	Smooth Buttonweed
SPEDIV	0	Spermolepis divaricata	Nt A-FORB	Forked Scale-Seed
SPEECH	3	Spermolepis echinata	Nt A-FORB	Bristly-Fruited Spermolepis
SPEINE	3	Spermolepis inermis	Nt A-FORB	Scaleseed
SPHFEN	*	SPHAERALCEA FENDLERI	Ad P-FORB	Plains Globe Mallow
SPHZEY	*	SPHENOCLEA ZEYLANDICA	Ad A-FORB	Chickenspike
SPHNIT	7	Sphenopholis nitida	Nt P-GRASS	Shining Wedge Grass
SPHOBM†	6	Sphenopholis obtusata var. major	Nt P-GRASS	Slender Wedge Grass
SPHOBO†	5	Sphenopholis obtusata var. obtusata	Nt P-GRASS	Prairie Wedge Grass
SPHPEN	10	Sphenopholis pensylvanica	Nt P-GRASS	Swamp Oats
SPIMAR	8	Spigelia marilandica	Nt P-FORB	Pink-Root
SPIVAN	*	SPIRAEA × VANHOUTTEI	Ad SHRUB	Garden Spiraea
SPIALB	9	Spiraea alba	Nt SHRUB	Meadowsweet

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
SPIDOU	*	SPIRAEA DOUGLASII	Ad SHRUB	Douglas' Meadow Sweet
SPIJAP	*	SPIRAEA JAPONICA	Ad SHRUB	Japanese Spiraea
SPIPRU	*	SPIRAEA PRUNIFOLIA	Ad SHRUB	Bridal Wreath
SPITOM	10	Spiraea tomentosa	Nt SHRUB	Steeple Bush
SPICER	5	Spiranthes cernua	Nt P-FORB	Nodding Ladies' Tresses
SPILAC	6	Spiranthes lacera	Nt P-FORB	Slender Ladies' Tresses
SPILUC	10	Spiranthes lucida	Nt P-FORB	Early Ladies' Tresses
SPIMAG	7	Spiranthes magnicamporum	Nt P-FORB	Dune Ladiess' Tresses
SPIOVA	8	Spiranthes ovalis var. erostellata	Nt P-FORB	Oval Ladies' Tresses
SPITUB	6	Spiranthes tuberosa	Nt P-FORB	Little Ladies' Tresses
SPIVER	8	Spiranthes vernalis	Nt P-FORB	Spring Ladies' Tresses
SPIPOL	5	Spirodela polyrhiza	Nt P-FORB	Big Duckweed
SPIPUN	*	SPIRODELA PUNCTATA	Ad P-FORB	Greater Duckweed
SPOAIR	*	SPOROBOLUS AIROIDES	Ad P-GRASS	Fine-Top Salt Grass
SPOCLA	5	Sporobolus clandestinus	Nt P-GRASS	Rough Rush Grass
SPOCOC†	3	Sporobolus compositus var. compositrus	Nt P-GRASS	Rough Dropseed
SPOCOD†	4	Sporobolus compositus var. drummondii	Nt P-GRASS	Rough Dropseed
SPOCOA†	2	Sporobolus compositus var. macer	Nt P-GRASS	Rough Dropseed
SPOCRY	4	Sporobolus cryptandrus	Nt P-GRASS	Sand Dropseed
SPOHET	6	Sporobolus heterolepis	Nt P-GRASS	Prairie Dropseed
SPOIND	*	SPOROBOLUS INDICUS	Ad P-GRASS	Smut Grass
SPONEG	2	Sporobolus neglectus	Nt A-GRASS	Small Rush Grass
SPOOZA	2	Sporobolus ozarkanus	Nt A-GRASS	Ozark Dropseed
SPOPYR	*	SPOROBOLUS PYRAMIDATUS	Ad P-GRASS	Whorled Dropseed
SPOVAG	0	Sporobolus vaginiflorus	Nt A-GRASS	Sheathed Rush Grass
STAASP	10	Stachys aspera	Nt P-FORB	Rough Hedge Nteele
STAHIS	6	Stachys hispida	Nt P-FORB	Marsh Hedge Nettle
STAPIL	6	Stachys pilosa	Nt P-FORB	Woundwort
STATEN	4	Stachys tenuifolia	Nt P-FORB	Rough Hedge Nettle
STATRI	5	Staphylea trifolia	Nt SHRUB	Bladdernut
STEHIA	7	Steinchisma hians	Nt P-GRASS	Gaping Panic Grass
STELGR†	*	STELLARIA GRAMINEA	Ad P-FORB	Common Stitchwort
STELON	6	Stellaria longifolia	Nt P-FORB	Stitchwort
STEMEA	*	STELLARIA MEADIA	Ad A-FORB	Common Chickweed
STENEG	*	STELLARIA NEGLECTA	Ad A-FORB	Greater Chickweed
STEPAL	*	STELLARIA PALLIDA	Ad A-FORB	Sand Chickweed
STENGR†	8	Stenanthium gramineum	Nt P-FORB	Featherbells
STELIN	7	Stenosiphon linifolius◀	Nt B-FORB	False Gaura
STESEC	*	STENOTAPHRUM SECUNDATUM	Ad P-GRASS	St. Augustine Grass

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
STISPA	8	Stipa spartea	Nt P-GRASS	Porcupine Grass
STRHEH†	2	Strophostyles helvola var. helvola◀	Nt A-FORB	Trailing Wild Bean
STRHEM†	4	Strophostyles helvola var. missouriensis◀	Nt A-FORB	Trailing Wild Bean
STRLEI	2	Strophostyles leiosperma	Nt A-FORB	Small Wild Bean
STRUMB	3	Strophostyles umbellata	Nt P-FORB	Pink Wild Bean
STYPIC	10	Stylisma pickeringii var. pattersonii	Nt P-FORB	Patterson's Stylisma
STYDIP	7	Stylophorum diphyllum	Nt P-FORB	Celandine Poppy
STYBIF	5	Stylosanthes biflora	Nt P-FORB	Pencil Flower
STYAME	9	Styrax americanus	Nt SHRUB	American Snowbell
STYGRA	8	Styrax grandifolius	Nt SHRUB	Big-Leaf Snowbell
SUACAL	*	SUAEDA CALCEOLIFORMIS	Ad A-FORB	Sea Blite
SULSUL	10	Sullivantia sullivantii	Nt P-FORB	Sullivantia
SYMALB	*	SYMPHORICARPOS ALBUS	Ad SHRUB	Snowberry
SYMOCC	10	Symphoricarpos occidentalis	Nt SHRUB	Wolfberry
SYMORB	1	Symphoricarpos orbiculatus	Nt SHRUB	Coralberry
SYMAME	10	Symphyotrichum × amethystinum	Nt P-FORB	Amethyst Aster
SYMANO	6	Symphyotrichum anomalum	Nt P-FORB	Blue Aster
SYMCIL	*	SYMPHYOTRICHUM CILIATUM	Ad A-FORB	Rayless Aster
SYMCOR	7	Symphyotrichum cordifolium	Nt P-FORB	Heart-Leaved Aster
SYMDRU	4	Symphyotrichum drummondii	Nt P-FORB	Drummond's Aster
SYMDUM	7	Symphyotrichum dumosum var. strictior	Nt P-FORB	Bushy Aster
SYMERI	5	Symphyotrichum ericoides	Nt P-FORB	Heath Aster
SYMFAL	*	SYMPHYOTRICHUM FALCATUM subsp. COMMUTATUM	Ad P-FORB	White Prairie Aster
SYMLAE	7	Symphyotrichum laeve	Nt P-FORB	Smooth Blue Aster
SYMLAI†	3	Symphyotrichum lanceolatum var. interior	Nt P-FORB	Marsh Aster
SYMLAL†	3	Symphyotrichum lanceolatum var. lanceolatum	Nt P-FORB	Panicled Aster
SYMLAT	3	Symphyotrichum lateriflorum	Nt P-FORB	Side-Flowering Aster
SYMNOV	4	Symphyotrichum novae-angliae	Nt P-FORB	New England Aster
SYMOBL	6	Symphyotrichum oblongifolium	Nt P-FORB	Aromatic Aster
SYMONT	3	Symphyotrichum ontarionis	Nt P-FORB	Ontario Aster
SYMOOL	7	Symphyotrichum oolentangiense	Nt P-FORB	Azure Aster
SYMPAR	4	Symphyotrichum parviceps	Nt P-FORB	Small-Headed Aster
SYMPAT	5	Symphyotrichum patens	Nt P-FORB	Spreading Aster
SYMPIP†	0	Symphyotrichum pilosum var. pilosum	Nt P-FORB	Hairy Aster
SYMPIG†	2	Symphyotrichum pilosum var. pringlei◀	Nt P-FORB	Hairy Aster
SYMPRA	6	Symphyotrichum praealtum	Nt P-FORB	Willow Aster
SYMPUN	10	Symphyotrichum puniceum	Nt P-FORB	Swamp Aster
SYMRAC	5	Symphyotrichum racemosum var. subdumosum	Nt P-FORB	Small White Aster

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
SYMSER	9	Symphyotrichum sericeum	Nt P-FORB	Silky Aster
SYMSUB	*	SYMPHYOTRICHUM SUBULATUM var. LIGULATUM	Ad A-FORB	Salt Marsh Aster
SYMTUR	6	Symphyotrichum turbinellum	Nt P-FORB	Prairie Aster
SYMURO	4	Symphyotrichum urophyllum	Nt P-FORB	Arrow-Leaved Aster
SYMOFF	*	SYMPHYTUM OFFICINALE	Ad P-FORB	Common Comfrey
SYRVUL	*	SYRINGA VULGARIS	Ad SHRUB	Lilac
TAEINT	6	Taenidia integerrima	Nt P-FORB	Yellow Pimpernel
TAGERE	*	TAGETES ERECTA	Ad A-FORB	African Marigold
TAGPAT	*	TAGETES PATULA	Ad A-FORB	French Marigold
TALPAN	*	TALINUM PANICULATUM	Ad P-FORB	Panicled Flameflower
TAMRAM	*	TAMARIX RAMOSISSIMA	Ad SHRUB	French Tamarisk
TANBAL	*	TANACETUM BALSAMITA	Ad P-FORB	Costmary
TANPAR	*	TANACETUM PARTHENIUM	Ad P-FORB	Feverfew
TANVUL	*	TANACETUM VULGARE	Ad P-FORB	Tansy
TARERY	*	TARAXACUM ERYTHROSPERMUM	Ad P-FORB	Red-Seeded Dandelion
TAROFF	*	TARAXACUM OFFICINALE	Ad P-FORB	Common Dandelion
TAXDIS	8	Taxodium distichum	Nt TREE	Bald Cypress
TEPVIR	5	Tephrosia virginiana	Nt P-FORB	Goat's Rue
TETDAN	*	TETRADIUM DANIELII	Ad TREE	Korean Evodia
TEUCAC†	2	Teucrium canadense var. canadense	Nt P-FORB	Germander
TEUCAO†	2	Teucrium canadense var. occidentale	Nt P-FORB	Germander
THADEA	8	Thalia dealbata	Nt P-FORB	Thalia
THADAS	4	Thalictrum dasycarpum	Nt P-FORB	Purple Meadow Rue
THADIO	8	Thalictrum dioicum	Nt P-FORB	Early Meadow Rue
THAREV	5	Thalictrum revolutum	Nt P-FORB	Waxy Meadow Rue
THATHA	5	Thalictrum thalictroides	Nt P-FORB	Rue Anemone
THABAR	7	Thaspium barbinode	Nt P-FORB	Hairy Meadow Parsnip
THATRF†	6	Thaspium trifoliatum var. flavum	Nt P-FORB	Yellow Meadow Parsnip
THATRT†	6	Thaspium trifoliatum var. trifoliatum	Nt P-FORB	Purple Meadow Parsnip
THEFIL	5	Thelesperma filifolium	Nt B-FORB	Greenthread
THEMEG	*	THELESPERMA MEGAPOTAMICUM	Ad P-FORB	Rayless Greenthread
THEPAL	10	Thelypteris palustris var. pubescens	Nt FERN	Marsh Fern
THLALL	*	THLASPI ALLIACEUM	Ad A-FORB	Roadside Pennycress
THLARV	*	THLASPI ARVENSE	Ad A-FORB	Field Pennycress
TIDLAN	*	TIDESTROMIA LANUGINOSA	Ad A-FORB	Wooly Tidestromia
TILAMA†	5	Tilia americana var. americana	Nt TREE	Basswood
TILAMH†	7	Tilia americana var. heterophylla	Nt TREE	White Basswood
TIPDIS	10	Tipularia discolor	Nt P-FORB	Crane-Fly Orchid
TIQNUT	*	TIQUILIA NUTTALLII	Ad P-FORB	Rosette Tiquilia

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
TORARV	*	TORILIS ARVENSIS	Ad A-FORB	Field Hedge Parsley
TORJAP	*	TORILIS JAPONICA	Ad A-FORB	Japanese Hedge Parsley
TORNOD	*	TORILIS NODOSA	Ad A-FORB	Knotted Hedge Parsley
TORPAL	10	Torreyochloa pallida	Nt P-GRASS	Pale Manna Grass
TOXPUB	7	Toxicodendron pubescens	Nt W-VINE	Eastern Poison Oak
TOXRAD	1	Toxicodendron radicans	Nt W-VINE	Poison Ivy
TRADIF	6	Trachelospermum difforme	Nt W-VINE	Climbing Dogbane
TRABRA	7	Tradescantia bracteata	Nt P-FORB	Long-Bracted Spiderwort
TRAERN	8	Tradescantia ernestiana	Nt P-FORB	Palmer's Spiderwort
TRALON	8	Tradescantia longipes	Nt P-FORB	Wild Crocus
TRAOHI	3	Tradescantia ohiensis	Nt P-FORB	Common Spiderwort
TRAOZA	10	Tradescantia ozarkana	Nt P-FORB	Ozark Spiderwort
TRASUB	8	Tradescantia subaspera	Nt P-FORB	Zigzag Spiderwort
TRATHA	9	Tradescantia tharpii	Nt P-FORB	Tharp's Spiderwort
TRAVIR	6	Tradescantia virginiana	Nt P-FORB	Virginia Spiderwort
TRABET	4	Tragia betonicifolia	Nt P-FORB	Noseburn
TRACOR	9	Tragia cordata	Nt P-FORB	Twining Tragia
TRARAM	7	Tragia ramosa	Nt P-FORB	Branching Tragia
TRADUB	*	TRAGOPOGON DUBIUS	Ad B-FORB	Yellow Salsify
TRAPOR	*	TRAGOPOGON PORRIFOLIUS	Ad B-FORB	Meadow Salsify
TRAPRA	*	TRAGOPOGON PRATENSIS	Ad B-FORB	Common Goat's Beard
TRACAR	10	Trautvettaria caroliniensis	Nt P-FORB	False Bugbane
TREAET	7	Trepocarpus aethusae	Nt A-FORB	Whitenymph
TRITUB	10	Triadenum tubulosum	Nt P-FORB	Marsh St. John's Wort
TRIWAL	9	Triadenum walteri	Nt P-FORB	Walter's Marsh St. John's Wort
TRIPOR	*	TRIANTHEMA PORTULACASTRUM	Ad P-FORB	Desert Purslane
TRITER	*	TRIBULUS TERRESTRIS	Ad A-FORB	Caltrop
TRIPLA	9	Trichophorum planifolium	Nt P-SEDGE	Wood Club-Rush
TRIBRA	4	Trichostema brachiatum	Nt A-FORB	False Pennyroyal
TRIDIC	6	Trichostema dichotomum	Nt A-FORB	Blue Curls
TRISET	10	Trichostema setaceum	Nt A-FORB	Bristly Blue Curls
TRIFLC†	6	Tridens flavus var. chapmanii	Nt P-GRASS	Chapman's Redtop
TRIFLF†	1	Tridens flavus var. flavus	Nt P-GRASS	False Redtop
TRIMUT	10	Tridens muticus var. elongatus	Nt P-GRASS	Long-Panicled Three-Toothed Grass
TRISTC†	5	Tridens strictus	Nt P-GRASS	Longspike Tridens
TRIARV	*	TRIFOLIUM ARVENSE	Ad A-FORB	Rabbit-Foot Clover
TRIAUR	*	TRIFOLIUM AUREUM	Ad A-FORB	Yellow Hop Clover
TRICAM	*	TRIFOLIUM CAMPESTRE	Ad A-FORB	Low Hop Clover

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
TRICAR	10	Trifolium carolinianum	Nt P-FORB	Carolina Clover
TRIDUB	*	TRIFOLIUM DUBIUM	Ad A-FORB	Little Hop Clover
TRIHYB	*	TRIFOLIUM HYBRIDUM	Ad P-FORB	Alsike Clover
TRIINC	*	TRIFOLIUM INCARNATUM	Ad A-FORB	Crimson Clover
TRIPRA	*	TRIFOLIUM PRATENSE	Ad P-FORB	Red Clover
TRIREF	8	Trifolium reflexum	Nt A-FORB	Buffalo Clover
TRIREP	*	TRIFOLIUM REPENS	Ad P-FORB	White Clover
TRIRES	*	TRIFOLIUM RESUPINATUM	Ad A-FORB	Persian Clover
TRISTO	10	Trifolium stoloniferum	Nt P-FORB	Running Buffalo Clover
TRISTT†	*	TRIFOLIUM STRIATUM	Ad A-FORB	Knotted Clover
TRIVES	*	TRIFOLIUM VESCICULOSUM	Ad A-FORB	Arrowleaf Clover
TRIFLE	8	Trillium flexipes	Nt P-FORB	Declined Trillium
TRINIV	9	Trillium nivale	Nt P-FORB	Snow Trillium
TRIPUS	9	Trillium pusillum var. ozarkanum	Nt P-FORB	Ozark Wake Robin
TRIREC	6	Trillium recurvatum	Nt P-FORB	Red Trillium
TRISES	5	Trillium sessile	Nt P-FORB	Toad Trillium
TRIVIE†	7	Trillium viride	Nt P-FORB	Blunt-Leaved Green Trillium
TRIVIS†	7	Trillium viridescens	Nt P-FORB	Sharp-Leaved Green Trillium
TRIBIF	3	Triodanis biflora	Nt A-FORB	Small Venus' Looking Glass
TRIHOL	10	Triodanis holzingeri	Nt A-FORB	Holzinger's Venus' Looking Glass
TRILAM	6	Triodanis lamprosperma	Nt A-FORB	Shining-Seed Venus' Looking Glass
TRILEP	5	Triodanis leptocarpa	Nt A-FORB	Venus' Looking Glass
TRIPFL†	2	Triodanis perfoliata	Nt A-FORB	Perfoliate Venus' Looking Glass
TRIOAN†	6	Triosteum angustifolium	Nt P-FORB	Yellow-Flowered Horse Gentian
TRIOAU†	6	Triosteum aurantiacum	Nt P-FORB	Early Horse Gentian
TRIOPE†	4	Triosteum perfoliatum	Nt P-FORB	Late Horse Gentian
TRITRI	9	Triphora trianthophora	Nt P-FORB	Nodding Pogonia
TRIPUR	7	Triplasis purpurea	Nt A-GRASS	Sand Grass
TRIINO	*	TRIPLEUROSPERMUM INODORUM	Ad A-FORB	Scentless Chamomile
TRIDAC	5	Tripsacum dactyloides	Nt P-GRASS	Gama Grass
TRIFLA	*	TRISETUM FLAVESCENS	Ad P-GRASS	Yellow Oats
TRIAES	*	TRITICUM AESTIVUM	Ad A-GRASS	Wheat
TSUCAN	*	TSUGA CANADENIS	Ad TREE	Eastern Hemlock
TURGLA	8	Turritis glabra	Nt B-FORB	Tower Mustard
TYPGLA	0	Typha × glauca	Nt P-FORB	Blue Cattail
TYPANG	0	Typha angustifolia	Nt P-FORB	Narrow-Leaved Cattail
TYPDOM	2	Typha domingensis	Nt P-FORB	Southern Cattail

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
TYPLAT	1	Typha latifolia	Nt P-FORB	Common Cattail
ULMINT	*	ULMUS × INTERMEDIA	Ad TREE	Hybrid Elm
ULMALA	4	Ulmus alata	Nt TREE	Winged Elm
ULMAME	4	Ulmus americana	Nt TREE	American Elm
ULMCRA	10	Ulmus crassifolia	Nt TREE	Cedar Elm
ULMMIN	*	ULMUS MINOR	Ad TREE	English Elm
ULMPUM	*	ULMUS PUMILA	Ad TREE	Siberian Elm
ULMRUB	5	Ulmus rubra	Nt TREE	Slippery Elm
ULMTHO	10	Ulmus thomasi	Nt TREE	Rock Elm
UROPLA	*	UROCHLOA PLATYPHYLLA	Ad A-GRASS	Fringed Signal Grass
URORAM	*	UROCHLOA RAMOSA	Ad A-GRASS	Browntop Millet
UROTEX	*	UROCHLOA TEXANA	Ad A-GRASS	Texas Millet
URTCHA	8	Urtica chamaedryoides	Nt A-FORB	Nettle
URTDID†	*	URTICA DIOICA subsp. DIOICA	Ad P-FORB	European Nettle
URTDIG†	3	Urtica dioica subsp. gracilis	Nt P-FORB	Tall Nettle
URTURE	*	URTICA URENS	Ad A-FORB	Burning Nettle
UTRGIB	6	Utricularia gibba	Nt P-FORB	Humped Bladderwort
UTRMIN	10	Utricularia minor	Nt P-FORB	Lesser Bladderwort
UTRSUB	10	Utricularia subulata	Nt P-FORB	Hair Bladderwort
UTRVUL	7	Utricularia vulgaris subsp. macrorhiza	Nt P-FORB	Great Bladderwort
UVUGRA	6	Uvularia grandiflora	Nt P-FORB	Bellwort
UVUSES	8	Uvularia sessilifolia	Nt P-FORB	Little Bellwort
VACHIS	*	VACCARIA HISPANICA	Ad A-FORB	Cow Herb
VACARB	6	Vaccinium arboreum	Nt SHRUB	Farkleberry
VACCOR	*	VACCINIUM CORYMBOSUM	Ad SHRUB	Highbush Blueberry
VACPAL	4	Vaccinium pallidum	Nt SHRUB	Late Low Blueberry
VACSTA	6	Vaccinium stamineum	Nt SHRUB	Deerberry
VALLOC	*	VALERIANELLA LOCUSTA	Ad A-FORB	Corn Salad
VALOZA	8	Valerianella ozarkana	Nt A-FORB	Ozark Corn Salad
VALRAD	0	Valerianella radiata	Nt A-FORB	Beaked Corn Salad
VALAME	10	Vallisneria americana	Nt P-FORB	Eel Grass
VERWOO	8	Veratrum woodii	Nt P-FORB	False Hellebore
VERBLA	*	VERBASCUM BLATTARIA	Ad B-FORB	Moth Mullein
VERLYC	*	VERBASCUM LYCHNITIS	Ad B-FORB	White Mullein
VERPHL	*	VERBASCUM PHLOMOIDES	Ad B-FORB	Clasping Mullein
VERTHA	*	VERBASCUM THAPSUS	Ad B-FORB	Common Mullein
VERBON	*	VERBENA BONARIENSIS	Ad A-FORB	Garden Vervain
VERBRC†	0	Verbena bracteata	Nt P-FORB	Creeping Vervain
VERBRS†	*	VERBENA BRASILIENSIS	Ad P-FORB	Brazilian Vervain

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
VERHAS	4	Verbena hastata	Nt P-FORB	Blue Vervain
VERSIM	3	Verbena simplex	Nt P-FORB	Narrow-Leaved Vervain
VERSTR	2	Verbena stricta	Nt P-FORB	Hoary Vervain
VERURT	2	Verbena urticifolia	Nt P-FORB	White Vervain
VERALT	4	Verbesina alternifolia	Nt P-FORB	Wingstem
VERENC	*	VERBESINA ENCELIOIDES	Ad A-FORB	Golden Crownbeard
VERHEL	5	Verbesina helianthoides	Nt P-FORB	Yellow Crownbeard
VERBVI†	5	Verbesina virginica	Nt P-FORB	White Crownbeard
VERARK	7	Vernonia arkansana	Nt P-FORB	Great Ironweed
VERBAL	2	Vernonia baldwinii◄	Nt P-FORB	Western Ironweed
VERFAS	7	Vernonia fasciculata	Nt P-FORB	Common Ironweed
VERGIG	6	Vernonia gigantea	Nt P-FORB	Tall Ironweed
VERMIS	5	Vernonia missurica	Nt P-FORB	Missouri Ironweed
VERAME	10	Veronica americana	Nt P-FORB	American Brooklime
VERANA	*	VERONICA ANAGALLIS-AQUATICA	Ad P-FORB	Blue Water Speedwell
VERARV	*	VERONICA ARVENSIS	Ad A-FORB	Corn Speedwell
VERBEC	*	VERONICA BECCABUNGA	Ad P-FORB	Brooklime
VERCAT	10	Veronica catenata	Nt P-FORB	Water Speedwell
VERCHA	*	VERONICA CHAMAEDRYS	Ad P-FORB	Germander Speedwell
VERHED	*	VERONICA HEDERIFOLIA	Ad A-FORB	Ivy-Leaved Speedwell
VERLON	*	VERONICA LONGIFOLIA	Ad P-FORB	Garden Speedwell
VERPEG†	0	Veronica peregrina	Nt A-FORB	Puslane Speedwell
VERPES†	*	VERONICA PERSICA	Ad A-FORB	Bird's Eye
VERPOL	*	VERONICA POLITA	Ad A-FORB	Wayside Speedwell
VERSCH	*	VERONICA SCHEEREI	Ad P-FORB	Creeping Speedwell
VERSER	*	VERONICA SERPYLLIFOLIA	Ad P-FORB	Thyme-Leaved Speedwell
VERTEU	*	VERONICA TEUCRIUM	Ad P-FORB	Saw-Leaved Speedwell
VERTRI	*	VERONICA TRIPHYLLOS	Ad A-FORB	Finger Speedwell
VEROVI†	7	Veronicastrum virginicum	Nt P-FORB	Culver's Root
VIBBRA	10	Viburnum bracteatum	Nt SHRUB	Ozark Arrowwood
VIBDEN	10	Viburnum dentatum	Nt SHRUB	Southern Arrow-Wood
VIBLAN	*	VIBURNUM LANTANA	Ad SHRUB	Wayfaring Tree
VIBLEN	5	Viburnum lentago	Nt SHRUB	Nannyberry
VIBMOL	8	Viburnum molle	Nt SHRUB	Arrow-Wood
VIBOPU	*	VIBURNUM OPULUS var. OPULUS	Ad SHRUB	European Highbush Cranberry
VIBPRU	4	Viburnum prunifolium	Nt SHRUB	Black Haw
VIBRAF	7	Viburnum rafinesquianum	Nt SHRUB	Downy Arrow-Wood
VIBREC	3	Viburnum recognitum	Nt SHRUB	Smooth Arrow-Wood
VIBRUF	4	Viburnum rufidulum	Nt SHRUB	Southern Black Haw

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
VICAME	8	Vicia americana	Nt P-FORB	American Vetch
VICCAR	6	Vicia caroliniana	Nt P-FORB	Wood Vetch
VICCRA	*	VICIA CRACCA	Ad P-FORB	Cow Vetch
VICGRA	*	VICIA GRANDIFLORA	Ad A-FORB	Big Flower Vetch
VICHIR	*	VICIA HIRSUTA	Ad A-FORB	Tiny Vetch
VICLUD	10	Vicia ludoviciana	Nt A-FORB	Deer Pea Vetch
VICMIN	7	Vicia minutiflora	Nt A-FORB	Pygmy-Flowered Vetch
VICSAT	*	VICIA SATIVA subsp. NIGRA	Ad A-FORB	Common Vetch
VICVIA†	*	VICIA VILLOSA subsp. VARIA	Ad A-FORB	Woolly-Pod Vetch
VICVII†	*	VICIA VILLOSA subsp. VILLOSA	Ad A-FORB	Hairy Vetch
VIGUNG	*	VIGNA UNGUICULATA	Ad A-FORB	Cowpea
VINMAJ	*	VINCA MAJOR	Ad SHRUB	Greater Periwinkle
VINMIN	*	VINCA MINOR	Ad SHRUB	Common Periwinkle
VIOAFF	10	Viola affinis	Nt P-FORB	Sand Violet
VIOARV	*	VIOLA ARVENSIS	Ad A-FORB	Field Pansy
VIOBIC	0	Viola bicolor	Nt A-FORB	Johnny Jump Up
VIOCUC	10	Viola cucullata	Nt P-FORB	Hooded Violet
VIOLAN	7	Viola lanceolata	Nt P-FORB	Lance-Leaved Violet
VIOMIS	6	Viola missouriensis	Nt P-FORB	Missouri Violet
VIONEP	3	Viola nephrophylla◀	Nt P-FORB	Blue Prairie Violet
VIOPAN†	10	Viola pallens	Nt P-FORB	Smooth White Violet
VIOPAT†	5	Viola palmata	Nt P-FORB	Three-Leaved Violet
VIOPEA†	5	Viola pedata	Nt P-FORB	Bird's Foot Violet
VIOPEF†	10	Viola pedatifida	Nt P-FORB	Prairie Violet
VIOPUB	5	Viola pubescens	Nt P-FORB	Smooth Yellow Violet
VIOSAG	6	Viola sagittata	Nt P-FORB	Arrow-Leaved Violet
VIOSOR	2	Viola sororia	Nt P-FORB	Hairy Wood Violet
VIOSTR	3	Viola striata	Nt P-FORB	Cream Violet
VIOTRI	*	VIOLA TRICOLOR	Ad A-FORB	Pansy Violet
VIOVIA	7	Viola viarum	Nt P-FORB	Plains Violet
VITNEG	*	VITEX NEGUNDO	Ad SHRUB	Chinese Chaste Tree
VITAES	5	Vitis aestivalis	Nt W-VINE	Summer Grape
VITCIN	3	Vitis cinerea	Nt W-VINE	Winter Grape
VITLAB	*	VITIS LABRUSCANA	Ad W-VINE	Fox Grape
VITPAL	6	Vitis palmata	Nt W-VINE	Red Grape
VITRIP	4	Vitis riparia	Nt W-VINE	Riverbank Grape
VITROT	10	Vitis rotundifolia	Nt W-VINE	Muscadine Grape
VITRUP	7	Vitis rupestris	Nt W-VINE	Sand Grape
VITVUL	5	Vitis vulpina	Nt W-VINE	Frost Grape

Table 1

ACRON	C	SCIENTIFIC NAME	PHYSIOG	COMMON NAME
VULBRO	*	VULPIA BROMOIDES	Ad A-GRASS	Brome-Like Fescue
VULELL	3	Vulpia elliotea	Nt A-GRASS	Squirrel-Tail Fescue
VULMYU	*	VULPIA MYUROS	Ad A-GRASS	Mouse-Tail Fescue
VULOCG†	2	Vulpia octoflora var. glauca	Nt A-GRASS	Six-Weeks Fescue
VULOCO†	3	Vulpia octoflora var. octoflora	Nt A-GRASS	Six-Weeks Fescue
WISFRU	4	Wisteria frutescens	Nt W-VINE	Wisteria
WISSIN	*	WISTERIA SINENSIS	Ad W-VINE	Chinese Wisteria
WOLBOR	9	Wolffia borealis	Nt P-FORB	Dotted Water Meal
WOLBRA	8	Wolffia braseliensis	Nt P-FORB	Pointed Water Meal
WOLCOL	7	Wolffia columbiana	Nt P-FORB	Common Water Meal
WOLGLA	10	Wolffiella gladiata	Nt P-FORB	Mud Midget
WOOOBT	5	Woodsia obtusa	Nt FERN	Cliff Fern
WOOARE	9	Woodwardia areolata	Nt FERN	Netted Chain Fern
XANSPI	*	XANTHIUM SPINOSUM	Ad A-FORB	Spiny Cocklebur
XANSTR	0	Xanthium strumarium	Nt A-FORB	Cocklebur
XYRJUP	10	Xyris jupicai	Nt A-FORB	Tall Yellow-Eyed Grass
XYRTOR	8	Xyris torta	Nt P-FORB	Yellow-Eyed Grass
YUCARK	9	Yucca arkansana	Nt SHRUB	Soft Soapweed
YUCGLA	10	Yucca glauca	Nt SHRUB	Soapweed
YUCSMA	*	YUCCA SMALLIANA	Ad SHRUB	Adam's Needle
ZANPAL	8	Zannichellia palustris	Nt P-FORB	Horned Pondweed
ZANAME	4	Zanthoxylum americanum	Nt SHRUB	Prickly Ash
ZEAMAY	*	ZEA MAYS	Ad A-GRASS	Corn
ZELCAL	*	ZELTNERA CALYCOSA	Ad A-FORB	Arizona Centaury
ZELTEX	9	Zeltnera texensis	Nt A-FORB	Lady Bird's Centaury
ZIGELE	10	Zigadenus elegans subsp. glaucus	Nt P-FORB	White Camas
ZIGNUT	10	Zigadenus nuttallii	Nt P-FORB	Death Camas
ZIZAQU	*	ZIZANIA AQUATICA	Ad A-GRASS	Wild Rice
ZIZPAL	10	Zizania palustris var. interior	Nt A-GRASS	Inland Wild Rice
ZIZMIL	9	Zizaniopsis miliacea	Nt P-GRASS	Water Millet
ZIZAPT	7	Zizia aptera	Nt P-FORB	Heart-Leaved Meadow Parsnip
ZIZAUR	5	Zizia aurea	Nt P-FORB	Golden Alexanders

ECOLOGICAL CHECKLIST OF THE MISSOURI FLORA

TABLE 2.
Synonymy crosswalk for the Missouri flora with Steyermark (1963), Yatskievych (1999, 2006, 2013), and USDA, NRCS (2014). An exclamation mark in the column indicates congruity with the names used in this list. See also discussion in the synonymy section of text.

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
ABUTILON THEOPHRASTI	!	!	!
Acaciella angustissima	Acacia angustissima var. hirta	!	Acacia angustissima var. hirta
Acalypha deamii	(A. rhomboidea var. deamii)	!	!
Acalypha gracilens	as vars. gracilens & fraseri	!	!
Acalypha monococca	A. gracilens var. monococca	!	!
Acalypha ostryifolia	A. "ostyraefolia"	!	A. "ostryifolia"
Acalypha rhomboidea	!	!	!
Acalypha virginica	!	!	!
ACER GINNALA	not included	!	!
Acer negundo	! incl. vars. interius, texanum & violaceum	! incl. var. texanum	! incl. var. interius, texanum, & violaceum
Acer rubrum var. drummondii	!	!	!
Acer rubrum var. rubrum	!	! in part	!
Acer rubrum var. trilobum	!	A. rubrum var. rubrum in part	!
Acer saccharinum	!	!	!
Acer saccharum subsp. floridanum	as var. floridanum	!	A. barbatum
Acer saccharum subsp. nigrum	A. nigrum	!	A. nigrum
Acer saccharum subsp. saccharum	as var. saccharum	!	! incl. var. schneckii
Acer saccharum subsp. schneckii	as f. schneckii	!	as var. schneckii
Achillea millefolium	! incl. subsp. lanulosa	!	! incl. var. occidentalis
ACHILLEA PTARMICA	!	!	!
ACHYRANTHES JAPONICA	not included	not included	!
Acmella oppositifolia	Spilanthes americana var. repens	as var. repens	as var. repens
Acmispon americanus	Lotus purshianus	!	L. unifoliolatus
Aconitum uncinatum	not included	!	!
ACORUS CALAMUS	!	!	!
Actaea pachypoda	!	!	!
Actaea racemosa	Cimicifuga racemosa	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
ACTINIDIA CHINENSIS var. DELICIOSA	not included	not included	!
Adiantum capillus-veneris	!	!	!
Adiantum pedatum	!	!	!
ADONIS ANNUA	A. aestivalis var. citrina	!	!
AEGILOPS CYLINDRICA	!	!	!
AESCHYNOMENE INDICA	not included	!	!
AESCHYNOMENE RUDIS	not included	!	!
Aesculus glabra var. glabra	!	!	!
Aesculus glabra var. arguta	!	!	!
Aesculus pavia	!	!	!
Agalinis aspera	Gerardia aspera	!	!
Agalinis auriculata	Gerardia auriculata	!	!
Agalinis fasciculata	Gerardia fasciculata	!	!
Agalinis gattingeri	Gerardia gattingeri	!	!
Agalinis heterophylla	Gerardia heterophylla	!	!
Agalinis purpurea	Gerardia purpurea	!	!
Agalinis skinneriana	Gerardia skinneriana	!	!
Agalinis tenuifolia	Gerardia tenuifolia incl. vars. macrophylla & parviflora	!	! incl. vars. macrophylla & parviflora
Agalinis viridis	Gerardia viridis	!	!
Agastache nepetoides	!	!	!
Agastache scrophulariifolia	A. "scrophulariaefolia"	!	!
Ageratina altissima	Eupatorium rugosum incl. var. tomentellum	!	!
AGERATUM CONYZOIDES	!	!	!
Agrimonia gryposepala	!	!	!
Agrimonia parviflora	!	!	!
Agrimonia pubescens	!	!	!
Agrimonia rostellata	!	!	!
AGROPYRON CRISTATUM	not included	!	!
AGROSTEMMA GITHAGO	!	!	!
AGROSTIS CAPILLARIS	A. tenuis	!	!
Agrostis elliottiana	!	!	!
AGROSTIS GIGANTEA	A. alba var. alba	!	!
Agrostis hyemalis	!	!	!
Agrostis perennans var. aestivalis	!	A. perennans in part	A. perennans in part
Agrostis perennans var. perennans	!	A. perennans in part	A. perennans in part

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
AGROSTIS STOLONIFERA	A. alba var. plaustris	as var. palustris	!
AILANTHUS ALTISSIMA	!	!	!
AIRA CARYOPHYLLEA	!	!	!
AIRA ELEGANS	!	!	!
AJUGA REPTANS	not included	!	!
AKEBIA QUINATA	not included	!	!
ALBIZIA JULIBRISSIN	"Albizzia" julibrissin	!	!
ALCEA ROSEA	Althaea rosea	!	!
Alisma gramineum	not included	!	!
Alisma subcordatum	A. plantago-aquatica var. parviflorum	!	!
Alisma triviale	A. plantago-aquatica incl. var. americanum	!	!
ALLIARIA PETIOLATA	not included	!	!
Allium burdickii	A. tricoccum in part	!	!
Allium canadense	!	as var. canadense	as var. canadense
ALLIUM CEPA	!	! incl. var. viviparum	!
Allium cernuum	!	!	!
Allium mutabile	!	A. canadense vars. lavendulare & mobilense	A. canadense vars. lavendulare & mobilense
ALLIUM SATIVUM	!	!	!
Allium stellatum	!	!	!
Allium tricoccum	in part	!	!
ALLIUM TUBEROSUM	not included	not included	!
ALLIUM VINEALE	!	!	! incl. subsp. compactum
ALNUS GLUTINOSA	not included	!	!
Alnus serrulata	!	!	!
Alopecurus aequalis	!	!	!
Alopecurus carolinianus	!	!	!
ALOPECURUS PRATENSIS	!	!	!
ALYSSUM ALYSSOIDES	!	!	!
ALYSSUM DESERTORUM	not included	!	!
Amaranthus albus	! incl. var. pubescens	!	!
AMARANTHUS ARENICOLA	A. torreyi	!	!
AMARANTHUS BLITOIDES	A. graecizans	!	!
AMARANTHUS BLITUM var. EMARGINATUS	not included	!	!
AMARANTHUS CAUDATUS	in part	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
AMARANTHUS CRUENTUS	A. caudatus in part	!	!
Amaranthus hybridus	in part	!	!
AMARANTHUS HYPOCHONDRIACUS	A. hybridus in part	!	!
AMARANTHUS PALMERI	!	!	!
AMARANTHUS POWELLII	!	!	!
AMARANTHUS RETROFLEXUS	!	!	!
AMARANTHUS SPINOSUS	!	!	!
AMARANTHUS TRICOLOR	not included	!	!
Amaranthus tuberculatus	! incl. A. tamarascinus	!	!
AMARANTHUS VIRIDIS	not included	!	!
AMBROSIA ACANTHICARPA	Franseria acanthicarpa	!	!
Ambrosia artemisiifolia	as var. elatior	!	as var. elatior
Ambrosia bidentata	!	!	!
Ambrosia psilostachya	A. coronopifolia	!	!
AMBROSIA TOMENTOSA	Franseria discolor	!	!
Ambrosia trifida	! incl. var. texana	!	! incl. var. texana
Amelanchier arborea	!	!	!
AMELANCHIER HUMILIS	!	!	!
Amianthium muscitoxicum	A. "muscaetoxicum"	!	!
Ammannia coccinea	!	!	!
Ammannia robusta	A. auriculata	!	!
AMMI MAJUS	!	!	!
AMMOSELINUM BUTLERI	(!)	!	!
Amorpha canescens	!	!	!
Amorpha fruticosa	! incl. vars. angustifolia, croceolanata, oblongifolia & tennesseensis	!	!
Amorpha nitens	not included	(!)	!
Ampelopsis arborea	!	!	!
AMPELOPSIS BREVIPEDUNCULATA	not included	!	!
Ampelopsis cordata	!	!	!
Amphiachyris dracunculoides	Gutierrezia dracunculoides	!	!
Amphicarpaea bracteata	"Amphicarpa" bracteata, incl. var. comosa var. bracteata	!	! incl. var. comosa
AMSINCKIA LYCOPSOIDES	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
AMSINCKIA MENZIESII	A. micrantha & A. retrorsa	!	!
AMSINCKIA TESSELLATA	!	!	!
Amsonia ciliata var. filifolia	!	!	A. ciliata var. tenuifolia
Amsonia illustris	!	!	!
Amsonia tabernaemontana var. salicifolia	! incl. var. gattingeri	!	!
Amsonia tabernaemontana var. tabernaemontana	!	!	!
ANAGALLIS ARVENSIS	!	! incl. subsp. foemina	!
Anagallis minima	Centunculus minimus	!	!
ANAPHALIS MARGARITACEA	!	!	!
ANCHUSA AZUREA	not included	!	!
ANCHUSA OFFICINALIS	not included	!	!
Andrachne phyllanthoides	!	!	Leptopus phyllanthoides
Andropogon gerardii	! incl. var. chrysocomus	! incl. var. chrysocomus	!
Andropogon gyrans	A. elliottii var. elliottii	!	!
Andropogon ternarius	!	!	!
Andropogon virginicus	!	!	!
Androsace occidentalis	!	!	!
Anemone acutiloba	Hepatica nobilis var. acuta	!	!
Anemone americana	Hepatica nobilis var. obtusa	!	!
Anemone canadensis	!	!	!
Anemone caroliniana	!	!	!
Anemone cylindrica	!	!	!
Anemone quinquefolia	not included	!	as var. bifolia
Anemone virginiana	!	!	!
ANETHUM GRAVEOLENS	!	!	!
Angelica venenosa	!	!	!
ANODA CRISTATA	!	!	!
Antennaria neglecta	! incl. var. campestris	!	!
Antennaria parlinii	A. plantaginifolia incl. vars. ambigens & arnoglossa	! incl. subsp. fallax	! incl. subsp. fallax
ANTHEMIS ARVENSIS	! incl. var. agrestis	!	!
ANTHEMIS COTULA	!	!	!
ANTHOXANTHUM ODORATUM	!	!	!
ANTHRISCUS CAUCALIS	A. scandicina	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
ANTIRRHINUM MAJUS	!	!	!
APERA INTERRUPTA	Agrostis interrupta	!	!
APERA SPICA-VENTI	Agrostis spica-venti	!	!
APHANES AUSTRALIS	not included	!	A. microcarpa
APHANOSTEPHUS SKIRRHOBASIS	not included	!	!
Apios americana	! incl. var. turrigera	!	!
APIUM GRAVEOLENS	!	!	as var. dulce
Aplectrum hyemale	!	!	!
Apocynum × floribundum	A. medium	!	!
Apocynum androsaemifolium	!	!	!
Apocynum cannabinum	! incl. var. pubescens	! in part	! in part
Apocynum sibiricum	! incl. var. cordigerum	A. cannabinum in part	A. cannabinum in part
Aquilegia canadensis	!	!	!
Arabidopsis lyrata	Arabis lyrata	!	Arabis lyrata
ARABIDOPSIS THALIANA	!	!	!
Arabis hirsuta	as vars. adpressipilis & pycnocarpa	as vars. adpressipilis & pycnocarpa	as var. pycnocarpa
ARACHIS HYPOGAEA	!	!	!
ARALIA ELATA	not included	not included	!
Aralia nudicaulis	!	!	!
Aralia racemosa	!	!	!
Aralia spinosa	!	!	!
ARCTIUM MINUS	! incl. A. tomentosum	!	!
ARENARIA SERPYLLIFOLIA	! incl. var. tenuior	! incl. var. tenuior	!
ARGEMONE ALBIFLORA	! incl. subsp. texana	! incl. subsp. texana	! incl. subsp. texana
ARGEMONE MEXICANA	!	!	!
Argyrochosma dealbata	Notholaena dealbata	!	!
Arisaema dracontium	!	!	!
Arisaema triphyllum	A. atrorubens	!	!
Aristida adscensionis	!	!	!
Aristida basiramea	!	!	!
Aristida desmantha	not included	!	!
Aristida dichotoma var. curtissii	!	!	!
Aristida dichotoma var. dichotoma	!	!	!
Aristida lanosa	!	!	!
Aristida longespica var. geniculata	! incl. A. intermedia	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Aristida longespica var. longespica	!	!	!
Aristida oligantha	!	!	!
Aristida purpurascens	!	!	!
Aristida ramosissima	!	!	!
Aristolochia serpentaria var. hastata	!	A. serpentaria in part	A. serpentaria in part
Aristolochia serpentaria var. serpentaria	!	A. serpentaria in part	A. serpentaria in part
Aristolochia tomentosa	!	!	!
ARMORACIA RUSTICANA	!	!	!
Arnoglossum atriplicifolium	Cacalia atriplicifolia	!	!
Arnoglossum plantagineum	Cacalia tuberosa	!	!
Arnoglossum reniforme	Cacalia muhlenbergii	!	!
Aronia melanocarpa	Pyrus melanocarpa	!	Photinia melanocarpa
ARRHENATHERUM ELATIUS	!	!	!
ARTEMISIA ABSINTHIUM	!	!	!
ARTEMISIA ANNUA	!	!	!
ARTEMISIA BIENNIS	!	!	!
Artemisia campestris subsp. caudata	A. caudata	!	!
ARTEMISIA CARRUTHII	!	!	!
Artemisia dracunculus	A. glauca incl. var. dracunculina	!	!
ARTEMISIA FRIGIDA	!	!	!
Artemisia ludoviciana var. ludoviciana	! incl. var. gnaphalodes	!	as subsp. ludoviciana
Artemisia ludoviciana var. mexicana	!	!	as subsp. mexicana
ARTEMISIA STELLARIANA	not included	!	!
ARTEMISIA VULGARIS	! incl. vars. glabra & latiloba	!	!
ARTHRAXON HISPIDUS	!	!	!
ARUM ITALICUM	not included	!	!
Aruncus dioicus var. pubescens	!	!	!
Arundinaria gigantea	!	!	!
ARUNDO DONAX	!	!	!
Asarum canadense	!	!	!
Asclepias amplexicaulis	!	!	!
Asclepias exaltata	not included	(!)	!
Asclepias hirtella	!	!	!
Asclepias incarnata	!	!	!
Asclepias meadii	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Asclepias perennis	!	!	!
Asclepias purpurascens	!	!	!
Asclepias quadrifolia	!	!	!
ASCLEPIAS SPECIOSA	(!)	!	!
Asclepias stenophylla	!	!	!
ASCLEPIAS SUBVERTICILLATA	not included	!	!
Asclepias sullivantii	!	!	!
Asclepias syriaca	as var. kansana	!	!
Asclepias tuberosa subsp. interior	as var. interior	!	!
Asclepias variegata	!	!	!
Asclepias verticillata	!	!	!
Asclepias viridiflora	! incl. vars. lanceolata & linearis	!	!
Asclepias viridis	!	!	!
Asimina triloba	!	!	!
ASPARAGUS OFFICINALIS	!	!	!
ASPARAGUS SPRENGERI	not included	not included	A. densiflorus
Asplenium × ebenoides	!	!	!
Asplenium × gravesii	!	!	!
Asplenium bradleyi	!	!	!
Asplenium montanum	not included	!	!
Asplenium pinnatifidum	!	!	!
Asplenium platyneuron	!	!	!
Asplenium resiliens	!	!	!
Asplenium rhizophyllum	Camptosorus rhizophyllus	!	!
Asplenium ruta-muraria	as var. cryptolepis	!	as var. cryptolepis
Asplenium trichomanes	!	!	!
ASTER TATARICUS	not included	!	!
Astragalus canadensis	!	!	!
Astragalus crassicarpus var. crassicarpus	A. caryocarpus	!	!
Astragalus crassicarpus var. trichocalyx	A. mexicanus var. trichocalyx	!	!
Astragalus distortus	!	!	!
Astragalus lotiflorus	!	!	!
Astranthium ciliatum	A. integrifolium	!	A. integrifolium subsp. ciliatum
Athyrium filix-femina	as vars. asplenioides & michauxii	as subspp. angustum & asplenioides	as subsp. angustum & asplenioides

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
ATOCION ARMERIA	not included	!	Silene armeria
ATRIPLEX ARGENTEA	(misidentifications)	!	!
ATRIPLEX HORTENSIS	!	!	!
ATRIPLEX MICRANTHA	not included	!	!
ATRIPLEX PATULA	A. patula var. patula	!	!
ATRIPLEX PROSTRATA	A. patula var. prostrata	!	!
ATRIPLEX ROSEA	!	!	!
ATRIPLEX TRUNCATA	A. argentea	!	!
ATRIPLEX WRIGHTII	not included	!	!
AUBRIETA DELTOIDEA	not included	!	!
Aureolaria flava var. calycosa	Gerardia flava var. calycosa	A. flava in part	A. flava var. flava in part
Aureolaria flava var. flava	Gerardia flava var. flava	A. flava in part	! in part, incl. var. macrantha
Aureolaria grandiflora var. pulchra	Gerardia grandiflora var. pulchra	!	!
Aureolaria grandiflora var. serrata	Gerardia grandiflora var. cinerea	!	as var. cinerea
Aureolaria pectinata	Gerardia pedicularia var. pectinata	!	!
AVENA FATUA var. FATUA	A. fatua	!	A. fatua
AVENA FATUA var. SATIVA	A. sativa	!	A. sativa
AXYRIS AMARANTHOIDES	!	!	!
Azolla caroliniana	not included	!	!
Azolla mexicana	!	!	!
BACCHARIS WRIGHTII	not included	not included	!
Bacopa rotundifolia	!	!	!
Baptisia alba var. macrophylla	B. leucantha	!	!
Baptisia australis var. minor	!	!	!
Baptisia bracteata var. leucophaea	B. leucophaea incl. var. glabrescens	!	!
BAPTISIA SPHAEROCARPA	!	!	!
BARBAREA VERNA	not included	!	!
BARBAREA VULGARIS	! incl. var. arcuata	!	!
Bartonia paniculata	!	!	!
Bartonia virginica	not included	!	!
BELAMCANDA CHINENSIS	!	!	!
Berberis canadensis	!	!	!
BERBERIS THUNBERGII	!	!	!
BERBERIS VULGARIS	!	!	!
Berchemia scandens	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Bergia texana	!	!	!
Berlandiera texana	!	!	B. betonicifolia
BERTEROA INCANA	!	!	!
Berula erecta	not included	as var. incisum	!
BETA VULGARIS	not included	!	!
Betula nigra	!	!	!
BIDENS ALBA var. RADIATA	not included	!	!
Bidens aristosa	! incl. vars. fritcheyi & mutica	! in part	in part
Bidens beckii	!	!	!
BIDENS BIPINNATA	!	!	!
Bidens cernua	! incl. vars. elliptica & integra	!	!
Bidens comosa	!	B. tripartita in part	B. tripartita
Bidens connata	as var. petiolata	B. tripartita in part	!
Bidens discoidea	!	!	!
Bidens frondosa	!	!	!
Bidens laevis	!	!	!
Bidens polylepis	! incl. var. retrorta	B. aristosa in part	B. aristosa in part
BIDENS TRICHOSPERMA	not included	!	incl. in B. coronata
Bidens vulgata	!	!	!
Bignonia capreolata	!	!	!
Blephilia ciliata	!	!	!
Blephilia hirsuta	!	!	!
Boechera canadensis	Arabis canadensis	!	Arabis canadensis
Boechera laevigata	Arabis laevigata	!	Arabis laevigata
Boechera missouriensis	Arabis missouriensis incl. var. deamii	!	Arabis missouriensis
Boechera shortii	Arabis shortii incl. var. phalacrocarpa	!	Arabis shortii
Boehmeria cylindrica	! incl. var. drummondiana	!	!
BOERHAAVIA ERECTA	!	!	"Boerhavia" erecta
Bolboschoenus fluviatilis	Scirpus fluviatilis	!	Schoenoplectus fluviatilis
Bolboschoenus maritimus subsp. paludosus	Scirpus paludosus	!	Schoenoplectus maritimus
Boltonia asteroides	as vars. latisquama, microcephala & recognita	as vars. latisquama & recognita	as vars. latisquama & recognita
Boltonia decurrens	B. asteroides var. decurrens	!	!
Boltonia diffusa	as var. interior	!	! incl. var. interior

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
BOTHRIOCHLOA BLADHII	not included	!	!
BOTHRIOCHLOA ISCHAEMUM	not included	not included	incl. var. songarica
Bothriochloa laguroides subsp. torreyana	Andropogon saccharoides	!	!
Botrychium biternatum	B. dissectum var. tenuifolium	!	!
Botrychium dissectum	! incl. var. obliqum	!	!
Botrychium virginianum	!	!	!
Bouteloua curtipendula	!	!	!
Bouteloua gracilis	!	!	!
Bouteloua hirsuta	!	!	!
BRACHIARIA ERUCIFORMIS	B. "erucaeformis"	!	!
Brachyelytrum erectum	!	!	!
Bradburia pilosa	Chrysopsis pilosa	!	Chrysopsis pilosa
Brasenia schreberi	!	!	!
BRASSICA JUNCEA	! incl. var. crispifolia	!	!
BRASSICA NAPUS	as var. napobrassica	!	!
BRASSICA NIGRA	!	!	!
BRASSICA RAPA	!	!	!
Brickellia eupatorioides var. eupatorioides	Kuhnia eupatorioides incl. var. corymbulosa	! incl. var. corymbulosa	! incl. var. corymbulosa
Brickellia eupatorioides var. texana	Kuhnia eupatorioides var. angustifolia	!	!
Brickellia grandiflora	!	!	!
BROMUS COMMUTATUS	not included	!	incl. in B. racemosus
BROMUS DIANDRUS	B. rigidus	!	as subsp. rigidus
BROMUS HORDACEUS	B. mollis	! incl. subsp. pseudothominei	! incl. subsp. "pseudothominii"
BROMUS INERMIS	!	!	!
BROMUS JAPONICUS	!	!	B. arvensis
Bromus latiglumis	!	!	!
Bromus nottowayanus	not included	!	!
Bromus pubescens	B. purgans	!	!
BROMUS RACEMOSUS	!	!	in part
BROMUS SECALINUS	!	!	!
BROMUS SQUARROSUS	!	!	!
BROMUS STERILIS	!	!	!
BROMUS TECTORUM	!	!	!
BROMUS WILLDENOWII	B. catharticus	!	B. catharticus
BROUSSONETIA PAPYRIFERA	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
BRUNNERA MACROPHYLLA	not included	!	!
Brunnichia ovata	B. cirrhosa	!	!
Buchloe dactyloides	!	!	Bouteloua dactyloides
Buchnera americana	!	!	!
BUDDLEJA DAVIDII	not included	!	!
BUGLOSSOIDES ARVENSE	Lithospermum arvense	!	B. "arvensis"
Bulbostylis capillaris	! incl. vars. crebra & isopoda	!	!
BUPLEURUM ROTUNDIFOLIUM	!	!	!
Cabomba caroliniana	!	!	!
Calamagrostis canadensis	! incl. var. macouniana	!	! incl. var. macouniana
Calamagrostis porteri subsp. insperata	C. insperata	!	!
Calamagrostis stricta subsp. inexpansa	C. inexpansa var. brevior	!	!
CALAMOVILFA LONGIFOLIA	!	!	!
Callicarpa americana	!	!	!
CALLICARPA DICHOTOMA	not included	!	!
Callirhoe alcaeoides	!	!	!
Callirhoe bushii	C. papaver incl. var. bushii	!	!
Callirhoe digitata	!	!	!
Callirhoe involucrata	!	!	!
Callirhoe triangulata	!	!	!
Callitriche heterophylla	!	!	!
Callitriche palustris	not included	!	!
Callitriche terrestris	!	!	!
Calopogon oklahomensis	C. pulchellus in part	!	!
Calopogon tuberosus	C. pulchellus in part	!	!
Caltha palustris	not included	!	!
CALYCANTHUS FLORIDUS	not included	!	as var. glaucus
Calycocarpum lyonii	C. "lyoni"	!	!
Calylophus serrulatus	Oenothera serrulata	Oenothera serrulata	!
Calystegia macounii	Convolvulus spithamaeus in part	!	!
CALYSTEGIA PUBESCENS	Convolvulus pellitus	!	C. hederacea
Calystegia sepium	Convolvulus sepium var. sepium	!	as subspp. americana & angulata
Calystegia silvatica subsp. fraterniflora	Convolvulus sepium var. fraterniflorus	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Calystegia spithamaea	Convolvulus spithamaeus in part	!	!
Camassia angusta	!	!	!
Camassia scilloides	!	!	!
CAMELINA MICROCARPA	!	!	!
CAMELINA SATIVA	!	!	!
Campanula americana	!	!	Campanulastrum americanum
Campanula aparinoides	!	!	!
CAMPANULA RAPUNCULOIDES	!	!	!
Campanula rotundifolia	!	!	!
Campsis radicans	!	!	!
CANAVALIA ENSIFORMIS	!	!	!
CANNABIS SATIVA	!	!	!
CAPSELLA BURSA-PASTORIS	!	!	!
CAPSICUM ANNUUM	not included	!	!
Cardamine bulbosa	!	!	!
Cardamine concatenata	Dentaria laciniata	!	!
Cardamine diphylla	not included	!	!
Cardamine douglasii	!	!	!
CARDAMINE FLEXUOSA	not included	!	!
CARDAMINE HIRSUTA	!	!	!
Cardamine parviflora var. arenicola	!	!	!
Cardamine pensylvanica	!	!	!
CARDIOSPERMUM HALICACABUM	!	!	!
CARDUUS CRISPUS	!	!	!
CARDUUS NUTANS	!	!	!
Carex × deamii	!	!	!
Carex × subimpressa	!	!	!
Carex abscondita	not included	!	!
Carex aggregata	!	!	!
Carex alata	!	!	!
Carex albicans var. albicans	C. artitecta	!	!
Carex albicans var. australis	C. physorhyncha	!	!
Carex albolutescens	!	!	!
Carex albursina	!	!	!
Carex amphibola	as var. amphibola	!	!
Carex annectens var. annectens	!	!	incl. in C. annectens

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Carex annectens var. xanthocarpa	!	!	incl. in C. annectens
Carex aquatilis	as var. altior	as var. substricta	!
Carex arkansana	!	!	!
Carex atherodes	!	!	!
Carex atlantica	not included	!	!
Carex aureolensis	not included	not included	!
Carex austrina	C. muehlenbergii var. australis	!	!
Carex bicknellii	in part	as var. bicknellii	!
Carex blanda	!	!	!
Carex brevior	!	!	!
Carex bromoides	not included	!	!
Carex bushii	!	!	!
Carex buxbaumii	!	!	!
Carex careyana	!	!	!
Carex caroliniana	!	!	!
Carex cephalophora	C. cephalophora var. cephalophora	!	!
Carex cherokeensis	!	!	!
Carex communis	!	!	!
Carex comosa	!	!	!
Carex complanata	as var. complanata	!	!
Carex conjuncta	!	!	!
Carex conoidea	!	!	!
Carex corrugata	C. amphibola var. globosa	!	!
Carex crawei	!	!	!
CAREX CRAWFORDII	not included	!	!
Carex crinita	! incl. var. brevicrinis	!	! incl. var. brevicrinis
Carex cristatella	!	!	!
Carex crus-corvi	!	!	!
Carex cumberlandensis	not included	not included	!
Carex davisii	!	!	!
Carex debilis	! incl. var. rudgei	!	!
Carex decomposita	!	!	!
Carex digitalis	! incl. var. macropoda	!	! incl. var. macropoda
CAREX DOUGLASII	!	!	!
Carex eburnea	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
CAREX ELEOCHARIS	not included	!	C. duriuscula
Carex emoryi	!	!	!
Carex festucacea	!	!	!
Carex fissa	not included	!	!
Carex flaccosperma	as var. flaccosperma	!	!
Carex frankii	! in part	! in part	! in part
Carex gigantea	!	!	!
Carex glaucodea	C. flaccosperma var. glaucodea	!	!
Carex gracilescens	!	!	!
Carex gracillima	!	!	!
Carex granularis	! incl. var. haleana	! incl. var. haleana	! incl. var. haleana
Carex gravida	! incl. var. lunelliana	!	!
Carex grayii	! incl. var. hispidula	!	!
Carex grisea	C. amphibola var. turgida	!	!
Carex haydenii	!	!	!
Carex hirsutella	C. complanata var. hirsuta	!	!
Carex hirtifolia	!	!	!
Carex hitchcockiana	!	!	!
Carex hyalinolepis	!	!	!
Carex hystericina	C. "hystricina"	!	!
Carex inops subsp. heliophila	C. pensylvanica var. digyna	!	!
Carex interior	!	!	!
Carex intumescens	!	!	!
Carex jamesii	!	!	!
Carex joorii	!	!	!
Carex lacustris	!	!	!
Carex laeviconica	!	!	!
Carex laevivaginata	!	!	!
Carex laxiculmis var. copulata	C. laxiculmis in part	C. laxiculmis in part	!
Carex laxiculmis var. laxiculmis	C. laxiculmis in part	C. laxiculmis in part	!
Carex laxiflora	(!)	!	!
Carex leavenworthii	!	!	!
Carex leptalea	!	!	!
Carex longii	not included	(!)	!
Carex louisianica	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Carex lupuliformis	!	!	!
Carex lupulina	!	!	!
Carex lurida	!	!	!
Carex meadii	!	!	!
Carex mesochorea	C. cephalophora var. mesochorea	!	!
Carex microdonta	!	!	!
Carex missouriensis	not included	not included	!
Carex molesta	in part	!	!
Carex molestiformis	C. molesta in part	!	!
Carex muehlenbergii var. enervis	as C. "muhlenbergii" var. enervis	!	!
Carex muehlenbergii var. muehlenbergii	as C. "muhlenbergii" var. "muhlenbergii"	!	!
Carex muskingumensis	!	!	!
CAREX NEBRASCENSIS	C. "nebraskensis"	!	!
Carex nigromarginata var. floridana	(!)	!	C. floridana
Carex nigromarginata var. nigromarginata	!	!	C. nigromarginata
Carex normalis	!	!	!
Carex oklahomensis	!	!	!
Carex oligocarpa	!	!	!
Carex opaca	C. bicknellii in part	C. bicknellii var. opaca	!
Carex oxylepis	!	!	!
Carex pellita	C. lanuginosa	!	!
Carex pensylvanica	as var. pensylvanica	!	!
Carex planispicata	C. amphibola var. rigida	!	!
CAREX PRAEGRACILIS	!	!	!
Carex prasina	not included	!	!
Carex radiata	C. rosea	!	!
Carex reniformis	not included	!	!
Carex retroflexa	C. retroflexa var. retroflexa	!	!
Carex reznicekii	not included	not included	not included
Carex rosea	C. convoluta	!	!
Carex sartwellii	!	!	!
Carex scabrata	!	!	!
Carex schweinitzii	!	!	!
Carex scoparia	!	!	!
Carex shortiana	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Carex socialis	not included	!	!
Carex sparganioides	!	!	!
Carex sprengelii	not included	!	!
Carex squarrosa	!	!	!
Carex sterilis	not included	!	!
Carex stipata	! incl. var. maxima	!	! incl. var. maxima
Carex straminea	!	!	!
Carex stricta	as var. strictior	!	!
Carex suberecta	!	!	!
Carex swanii	!	!	!
Carex sychnocephala	not included	!	!
Carex tenera	!	as var. echinoides	!
Carex tetanica	!	!	!
Carex texensis	C. retroflexa var. texensis	!	!
Carex timida	not included	not included	!
Carex tonsa var. rugosperma	not included	(!)	!
Carex tonsa var. tonsa	!	!	! incl. var. rugosperma
Carex torta	!	!	!
Carex triangularis	!	!	!
Carex tribuloides var. sangamonensis	! in part	! in part	!
Carex tribuloides var. tribuloides	! in part, incl. C. projecta	! in part	!
Carex trichocarpa	!	!	!
Carex typhina	!	!	!
Carex umbellata	! incl. C. abdita	!	!
Carex vesicaria var. monile	!	!	C. vesicaria
Carex virescens	!	!	!
Carex vulpinoidea	!	!	!
Carex willdenowii	not included	!	!
Carex woodii	misapplied	!	!
Carpinus caroliniana	! incl. var. virginiana	! incl. var. virginiana	! incl. subsp. virginiana
CARUM CARVI	!	!	!
Carya aquatica	!	!	!
Carya cordiformis	!	!	!
Carya glabra	!	! in part	!
Carya illinoinensis	C. "illinoensis"	!	!
Carya laciniosa	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Carya ovalis	! incl. vars. obcordata, obovalis & odorata	C. glabra in part	!
Carya ovata	!	!	!
Carya pallida	not included	!	!
Carya texana	! incl. var. villosa	!	!
Carya tomentosa	! incl. var. subcoriacea	!	C. alba
CASTANEA DENTATA	!	!	!
CASTANEA MOLLISSIMA	not included	!	!
Castanea pumila var. ozarkensis	C. ozarkensis	!	!
Castanea pumila var. pumila	not included	!	!
Castilleja coccinea	!	!	!
Castilleja purpurea	!	!	!
Castilleja sessiliflora	!	!	!
CATALPA BIGNONIOIDES	!	!	!
CATALPA OVATA	!	!	!
Catalpa speciosa	!	!	!
Caulophyllum thalictroides	!	!	!
Cayaponia quinqueloba	C. grandiflora	!	!
Ceanothus americanus	as vars. intermedius & pitcheri	!	!
Ceanothus herbaceus	C. ovatus incl. var. pubescens	!	!
CELASTRUS ORBICULATUS	not included	!	!
Celastrus scandens	!	!	!
CELOSIA ARGENTEA	as var. cristata	! incl. var. cristata	!
Celtis laevigata	! incl. var. texana	!	! incl. var. texana
Celtis occidentalis	! incl. vars. canina & pumila	!	!
Celtis pumila	C. tenuifolia incl. var. georgiana; C. laevigata var. smallii	!	C. tenuifolia, incl. var. georgiana
CENCHRUS CILIARIS	Pennisetum ciliare	!	Pennisetum ciliare
Cenchrus longispinus	! in part	! in part	!
Cenchrus spinifex	C. longispinus in part	C. longispinus in part	!
Centaurea americana	!	!	!
CENTAUREA CYANUS	!	!	!
CENTAUREA DIFFUSA	!	!	!
CENTAUREA DILUTA	not included	!	!
CENTAUREA MELITENSIS	!	!	!
CENTAUREA NIGRA	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
CENTAUREA NIGRESCENS	C. vouchinensis	!	!
CENTAUREA REPENS	!	!	Acroptilon repens
CENTAUREA SOLSTITIALIS	!	!	!
CENTAUREA STOEBE subsp. MICRANTHOS	C. maculosa	!	!
Centrosema virginianum	not included	!	!
Cephalanthus occidentalis	! incl. var. pubescens	!	!
Cerastium arvense subsp. strictum	C. arvense var. villosum in part	!	!
CERASTIUM BRACHYPETALUM	!	!	!
Cerastium brachypodum	!	!	!
CERASTIUM DIFFUSUM	C. tetrandrum	!	!
CERASTIUM DUBIUM	not included	(!)	!
CERASTIUM FONTANUM subsp. VULGARE	C. vulgatum	!	!
CERASTIUM GLOMERATUM	C. viscosum	!	!
Cerastium nutans	!	!	!
CERASTIUM PUMILUM	!	!	!
CERASTIUM SEMIDECANDRUM	!	!	!
Cerastium velutinum	C. arvense var. villosum in part	!	C. arvense subsp. velutinum
CERATOCEPHALUS TESTICULATUS	not included	!	"Ceratrocephala testiculata"
Ceratophyllum demersum	!	!	!
Ceratophyllum echinatum	!	!	!
CERATOSTIGMA PLUMBAGINOIDES	not included	!	!
Cercis canadensis	!	!	!
CHAENOMELES SPECIOSA	not included	!	!
CHAENORRHINUM MINUS	!	!	"Chaenorhinum" minus
Chaerophyllum procumbens	! incl. var. shortii	!	incl. var. shortii
Chaerophyllum tainturieri	! incl. var. floridanum & C. texanum	!	incl. var. dasycarpum
Chaetopappa asteroides	!	!	!
Chamaecrista fasciculata	Cassia fasciculata incl. vars. depressa & robusta	!	!
Chamaecrista nictitans	Cassia nictitans	!	!
Chasmanthium latifolium	Uniola latifolia	!	!
Chasmanthium laxum	Uniola laxa	as subsp. laxum	!
Chasmanthium sessilifolium	not included	C. laxum subsp. sessilifolium	!
Cheilanthes alabamensis	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Cheilanthes feei	!	!	!
Cheilanthes lanosa	!	!	!
Cheilanthes tomentosa	!	!	!
CHELIDONIUM MAJUS	!	!	!
Chelone glabra	! incl. var. linifolia	!	!
Chelone obliqua	as var. speciosa	!	as var. speciosa
CHENOPODIUM ALBUM	! incl. var. lanceolatum	!	in part, incl. var. microphyllum
CHENOPODIUM AMBROSIOIDES	! incl. var. anthelminticum	! incl. var. anthelminticum	!
Chenopodium berlandieri	as vars. boscianum & zschackei	incl. vars. boscianum & zschackii	in part, incl. vars. boscianum & zschackii
CHENOPODIUM BOTRYS	!	!	!
Chenopodium bushianum	!	!	C. berlandieri var. bushianum
CHENOPODIUM CAPITATUM	!	!	!
CHENOPODIUM DESICCATUM	as var. dessicatum	!	!
CHENOPODIUM FICIFOLIUM	not included	!	!
CHENOPODIUM GLAUCUM	! incl. var. salinum	! incl. var. salinum	!
CHENOPODIUM INCANUM	!	!	!
Chenopodium missouriense	!	!	C. album var. missouriense
CHENOPODIUM MURALE	!	!	!
CHENOPODIUM OPULIFOLIUM	not included	!	!
Chenopodium pallescens	!	!	!
Chenopodium pratericola	C. dessicatum var. leptophylloides	!	!
CHENOPODIUM PUMILIO	!	!	!
CHENOPODIUM RUBRUM	!	!	!
Chenopodium simplex	C. gigantospermum	!	!
Chenopodium standleyanum	!	!	!
Chenopodium strictum var. glaucophyllum	!	!	C. album var. striatum
CHENOPODIUM URBICUM	!	!	!
CHENOPODIUM WATSONII	not included	!	!
Chionanthus virginicus	C. "virginica"	!	!
Chloris verticillata	!	!	!
CHLORIS VIRGATA	!	!	!
CHORISPORA TENELLA	!	!	!
CICHORIUM INTYBUS	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Cicuta maculata	!	! incl. var. bolanderi	! incl. var. bolanderi
Cinna arundinacea	! incl. var. inexpansa	!	!
Circaea canadensis	C. quadrisulcata var. canadensis	!	Circaea lutetiana subsp. canadensis
Cirsium altissimum	!	!	!
CIRSIUM ARVENSE	!	!	!
CIRSIUM CANESCENS	not included	!	!
Cirsium carolinianum	!	!	!
Cirsium discolor	!	!	!
Cirsium muticum	!	!	!
CIRSIUM TEXANUM	not included	!	!
Cirsium undulatum	as var. megacephalum	!	as var. undulatum
CIRSIUM VULGARE	!	!	!
Cissus trifoliata	C. incisa	!	!
CITRULLUS LANATUS	C. vulgaris	!	!
CITRUS TRIFOLIATA	not included	!	Poncirus trifoliata
CLADIUM MARISCUS subsp. JAMAICENSE	not included	not included	!
Cladrastis kentukea	C. lutea	!	!
CLAYTONIA PERFOLIATA	not included	(!)	!
Claytonia virginica	!	!	!
Clematis catesbyana	not included	!	!
Clematis crispa	!	!	!
Clematis fremontii	as var. riehlii	!	!
Clematis pitcheri	!	!	!
CLEMATIS TERNIFLORA	C. dioscoreifolia	!	!
Clematis versicolor	!	!	!
Clematis viorna	!	!	!
Clematis virginiana	!	!	!
CLEOME HASSLERIANA	C. houtteana	!	!
Cleome serrulata	!	!	!
CLINOPODIUM ACINOS	Satureja acinos	!	Acinos arvensis
Clinopodium arkansanum	Satureja arkansana	!	!
Clitoria mariana	!	!	!
Cocculus carolinus	!	!	!
Coeloglossum viride	not included	as var. virescens	Dactylorhiza viridis
Coelorachis cylindrica	Manisuris cylindrica	!	!
Collinsia verna	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Collinsia violacea	!	!	!
Collinsonia canadensis	!	!	!
COLLOMIA LINEARIS	!	!	!
Comandra umbellata	C. richardsiana	!	!
COMMELINA CAROLINIANA	!	!	!
COMMELINA COMMUNIS	!	!	!
COMMELINA DIFFUSA	!	!	!
Commelina erecta	! incl. vars. angustifolia & deamiana	!	! incl. vars. angustifolia & deamiana
Commelina virginica	!	!	!
CONIUM MACULATUM	!	!	!
Conoclinium coelestinum	Eupatorium coelestinum	!	!
CONRINGIA ORIENTALIS	!	!	!
CONVALLARIA MAJALIS	not included	!	!
CONVOLVULUS ARVENSIS	!	!	!
Conyza canadensis var. canadensis	Erigeron canadensis	!	!
Conyza canadensis var. pusilla	Erigeron pusillus	!	!
Conyza ramosissima	Erigeron divaricatus	!	!
Corallorhiza odontorhiza	!	!	!
Corallorhiza wisteriana	! incl. C. trifida var. verna	!	!
Coreopsis grandiflora	! incl. var. harveyana	!	! incl. var. harveyana
Coreopsis lanceolata	! incl. var. villosa	!	!
Coreopsis palmata	!	!	!
Coreopsis pubescens	!	!	!
Coreopsis tinctoria	! incl. C. cardaminefolia	!	!
Coreopsis tripteris	! incl. var. deamii	!	!
CORIANDRUM SATIVUM	!	!	!
Corispermum americanum	C. nitidum	!	!
Corispermum pallassii	C. hyssopifolium	!	!
Corispermum villosum	C. orientale var. emarginatum	!	!
Cornus alternifolia	!	!	!
Cornus amomum subsp. obliqua	C. obliqua	!	C. obliqua
Cornus drummondii	C. "drummondi"	!	!
Cornus florida	!	!	!
Cornus foemina subsp. foemina	C. foemina	!	C. foemina

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Cornus foemina subsp. racemosa	C. racemosa	!	C. racemosa
Corydalis aurea subsp. aurea	C. aurea	!	C. aurea
Corydalis aurea subsp. occidentalis	C. montana	!	C. curvisiliqua subsp. occidentalis
Corydalis crystallina	!	!	!
Corydalis flavula	!	!	!
Corydalis micrantha subsp. australis	C. halei	!	!
Corydalis micrantha subsp. micrantha	C. micrantha	!	!
Corylus americana	! incl. var. indehiscens	!	!
COSMOS BIPINNATUS	!	!	!
COSMOS PARVIFLORUS	not included	!	!
COSMOS SULPHUREUS	!	!	!
COTA TINCTORIA	Anthemis tinctoria	!	Anthemis tinctoria
Cotinus obovatus	!	!	!
COTONEASTER ACUTIFOLIUS	not included	as var. lucidus	!
Crataegus berberifolia	C. englemanni	!	! incl. C. engelmannii
Crataegus biltmoreana	! incl. C. biltmoreana	!	C. intricata in part
Crataegus calpodendron	! incl. vars. globosa, hispidula, microcarpa, & mollicula	!	!
Crataegus coccinioides	! incl. C. locuples	!	!
Crataegus collina	! incl. vars. collicola, secta, sordida & succincta; C. hirtiflora, C. lettermanii	! incl. vars. hirsutiflora, lettermanii, sordida, succincta; C. spes-aestatum	C. punctata in part
Crataegus crus-galli	! incl. vars. barrettiana, bellica, exigua, leptophylla, macra, pachyphylla, & pyracanthifolia; C. acutifolia, C. hannibalensis, C. palmeri, C. pyracanthoides var. arborea, C. regalis incl. var. paradoxa, C. tantula, C. vallicola	! incl. vars. capillata & pyracanthifolia	! in part, incl. C. arborea, C. reverchonii
Crataegus fecunda	!	!	C. crus-galli in part
Crataegus gattingeri	!	!	C. pruinosa in part
Crataegus lanuginosa	!	!	!
Crataegus macracantha	C. succulenta var. pertomentosa	!	C. succulenta in part
Crataegus margarettae	! incl. var. brownei	!	C. "margarettiae"

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Crataegus marshallii	!	!	!
Crataegus mollis	! incl. C. lanuginosa, C. noelensis	! incl. vars. dumetosa, incisifolia, mollis; C. transmissippiensis	! incl. C. dispessa, C. lanuginosa
Crataegus neobushii	!	!	C. intricata in part
Crataegus padifolia	! incl. var. incarnata	! incl. var. incarnata	C. intricata in part
Crataegus phaenopyrum	!	!	!
Crataegus pruinosa	! incl. var. brachypoda; C. disjuncta, C. gattingeri, C. platycarpa, C. pruinosa incl. vars. aspera & bracteata, C. rugosa	! incl. vars. cognata, dissona, magnifolia, rugosa, & virella	! in part, incl. C. dissona
Crataegus reverchonii	as var. discolor	! incl. var. palmeri	!
Crataegus rubella	not included	!	C. intricata var. rubella
Crataegus schuettei	not included	!	!
Crataegus sicca	! incl. var. glabrifolia	! incl. var. glabrifolia	C. chrysocarpa
Crataegus spathulata	!	!	!
Crataegus succulenta	incl. var. neofluvialis	!	! in part
Crataegus texana	C. mollis in part	!	!
Crataegus uniflora	!	!	!
Crataegus viridis	! incl. vars. lanceolata, lutescens, & ovata; C. nitida	! incl. vars. glabriuscula, lanceolata, nitens, ovata; C. nitida	! incl. C. nitida & C. ovata
CREPIS CAPILLARIS	!	!	!
CREPIS PULCHRA	!	!	!
CREPIS SETOSA	!	!	!
CREPIS TECTORUM	!	!	!
Crotalaria sagittalis	!	!	!
CROTALARIA SPECTABILIS	!	!	!
Croton capitatus var. capitatus	!	!	!
Croton capitatus var. lindheimeri	!	!	!
Croton glandulosus var. septentrionalis	!	!	!
CROTON LINDHEIMERIANUS	not included	!	!
Croton michauxii	Crotonopsis linearis	!	!
Croton monanthogynus	!	!	!
CROTON TEXENSIS	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Croton wildenowii	Crotonopsis elliptica	!	Croton michauxii var. elliptica
CRYPSIS SCHOENOIDES	Heleochloa schoenoides	!	!
Cryptotaenia canadensis	!	!	!
Cubelium concolor	Hybanthus concolor	!	Hybanthus concolor
CUCUMIS MELO	!	!	!
CUCUMIS SATIVUS	not included	!	!
CUCURBITA FOETIDISSIMA	!	!	!
CUCURBITA PEPO var. OVIFERA	! in part	(!)	!
Cucurbita pepo var. ozarkana	C. pepo var. ovifera in part	!	!
Cunila origanoides	!	!	!
Cuphea viscosissima	C. petiolata	!	!
Cuscuta campestris	!	!	incl. in C. pentagona
Cuscuta cephalanthi	!	!	!
Cuscuta compacta	!	!	!
Cuscuta coryli	!	!	!
Cuscuta cuspidata	!	!	!
Cuscuta glomerata	!	!	!
Cuscuta gronovii	!	!	!
Cuscuta indecora	as var. neuropetala	!	as var. neuropetala
Cuscuta obtusiflora var. glandulosa	not included	not included	!
Cuscuta pentagona	!	!	in part
Cuscuta polygonorum	!	!	!
Cyclachaena xanthifolia	Iva xanthifolia	!	!
Cycloloma atriplicifolium	!	!	!
CYLINDROPUNTIA IMBRICATA	not included	(!)	!
CYMBALARIA MURALIS	!	!	!
Cynanchum laeve	!	!	!
CYNANCHUM LOUISEAE	not included	!	!
CYNODON DACTYLON	!	!	!
CYNOGLOSSUM CRETICUM	not included	not included	not included
CYNOGLOSSUM OFFICINALE	!	!	!
Cynoglossum virginianum	!	!	!
Cynosciadium digitatum	!	!	!
CYNOSURUS ECHINATUS	!	!	!
Cyperus acuminatus	!	!	!
Cyperus bipartitus	C. rivularis	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Cyperus compressus	!	!	!
Cyperus croceus	C. globulosus	!	!
Cyperus diandrus	!	!	!
CYPERUS DIFFORMIS	not included	not included	!
Cyperus echinatus	C. ovularis incl. var. sphaericus	!	!
Cyperus erythrorhizos	!	!	!
Cyperus esculentus	!	!	as var. leptostachys
Cyperus flavescens var. poiformis	as var. "poaeformis"	!	incl. in C. flavescens
CYPERUS FLAVICOMIS	not included	!	!
CYPERUS FUSCUS	not included	!	!
Cyperus grayoides	not included	!	!
Cyperus hystricinus	not included	!	!
CYPERUS IRIA	!	!	!
Cyperus lancastriensis	!	!	!
Cyperus lupulinus subsp. lupulinus	C. filiculmis	!	!
Cyperus lupulinus subsp. macilentus	C. filiculmis var. macilentus	!	!
Cyperus odoratus	! incl. C. ferruginescens	!	!
Cyperus plukenettii	!	!	!
Cyperus polystachyos var. texensis	!	!	!
Cyperus pseudovegetus	C. virens	!	!
Cyperus refractus	!	!	!
Cyperus retroflexus	not included	!	!
Cyperus retrofractus	C. dipsaciformis	!	!
CYPERUS RETRORSUS	(! as var. deeringianus)	not included	!
CYPERUS ROTUNDUS	!	!	!
Cyperus schweinitzii	!	!	!
Cyperus setigerus	!	!	!
Cyperus squarrosus	C. aristatus	!	!
Cyperus strigosus	! incl. var. robustior	!	!
Cypripedium calceolus var. parviflorum	!	!	C. parviflorum var. parviflorum
Cypripedium calceolus var. pubescens	!	!	C. parviflorum var. pubescens
Cypripedium candidum	!	!	!
Cypripedium reginae	!	!	!
Cystopteris bulbifera	!	!	!
Cystopteris protrusa	C. fragilis var. protrusa	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Cystopteris tennesseensis	C. fragilis var. fragilis	!	!
Cystopteris tenuis	C. fragilis var. mackayii	!	!
DACTYLIS GLOMERATA	!	!	!
Dalea candida	Petalostemon candidum	!	!
Dalea enneandra	!	!	!
Dalea gattingeri	not included	!	!
Dalea leporina	D. apolecuroides	!	!
Dalea multiflora	Petalostemon multiflorum	!	!
Dalea purpurea	Petalostemon purpureum	!	!
DALEA VILLOSA	not included	!	!
Danthonia spicata	! incl. var. longipila	!	!
Dasistoma macrophyllum	Seymeria macrophylla	!	D. "macrophylla"
DATURA INOXIA	D. "innoxia"	!	!
DATURA STRAMONIUM	! incl. var. tatula	!	!
DATURA WRIGHTII	not included	!	!
DAUCUS CAROTA	!	!	!
Daucus pusillus	!	!	!
Decodon verticillatus	!	!	!
DELPHINIUM AJACIS	!	!	Consolida ajacis
Delphinium carolinianum subsp. carolinianum	D. carolinianum incl. vars. crispum & nortonianum	!	!
Delphinium carolinianum subsp. virescens	D. virescens incl. var. penardi	!	!
DELPHINIUM CONSOLIDA	not included	!	Consolida regalis
Delphinium exaltatum	!	!	!
Delphinium treleasei	!	!	!
Delphinium tricorne	!	!	!
Dennstaedtia punctilobula	!	!	!
Deparia acrostichoides	Athyrium thelypteroides	!	!
Descurainia pinnata subsp. brachycarpa	as var. brachycarpa	!	!
Descurainia pinnata subsp. pinnata	as var. pinnata	!	!
DESCURAINIA SOPHIA	!	!	!
Desmanthus illinoensis	!	!	!
DESMANTHUS LEPTOLOBUS	!	!	!
Desmodium × humifusum	Desmodium humifusum	!	Desmodium humifusum

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Desmodium canadense	!	!	!
Desmodium canescens	!	!	!
Desmodium ciliare	!	!	!
Desmodium cuspidatum	! incl. var. longifolium	!	! incl. var. longifolium
Desmodium glabellum	D. paniculatum var. dillenii in part	!	!
Desmodium illinoense	!	!	!
Desmodium laevigatum	!	!	!
Desmodium marilandicum	!	!	!
Desmodium nuttallii	!	!	!
Desmodium obtusum	D. rigidum	!	!
Desmodium ochroleucum	!	!	!
Desmodium paniculatum	as var. paniculatum	!	!
Desmodium perplexum	D. paniculatum var. dillenii in part	!	!
Desmodium rotundifolium	!	!	!
Desmodium sessilifolium	!	!	!
Desmodium strictum	not included	!	!
Desmodium viridiflorum	!	!	!
DIANTHUS ARMERIA	!	!	!
DIANTHUS BARBATUS	!	!	!
DIANTHUS DELTOIDES	!	!	!
DIANTHUS PLUMARIUS	not included	!	!
DIAPERIA PROLIFERA	not included	!	Evax prolifera
Diarrhena americana	as var. americana	!	!
Diarrhena obovata	D. americana var. obovata	!	!
Dicentra canadensis	!	!	!
Dicentra cucullaria	!	!	!
Dichanthelium angustifolium	not included	not included	! in part
Dichanthelium annulum	Panicum annulum	P. dichotomum var. mattamuskeetense	D. dichotomum var. dichotomum in part
Dichanthelium ashei	Panicum commutatum var. ashei	Panicum commutatum var. ashei	D. commutatum in part
Dichanthelium bicknellii	Panicum bicknellii & P. calliphyllum	P. boreale in part	D. boreale in part
Dichanthelium boscii	Panicum boscii incl. var. molle	Panicum boscii	!
Dichanthelium clandestinum	Panicum clandestinum	Panicum clandestinum	D. clandestinum

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Dichanthelium columbianum	(Panicum columbianum)	P. portoricense	D. sabulorum var. thinium in part
Dichanthelium commonsianum	not included	not included	D. ovale var. addisonii
Dichanthelium commutatum var. commutatum	Panicum commutatum var. commutatum	Panicum commutatum var. commutatum	D. commutatum in part
Dichanthelium depauperatum	Panicum depauperatum	Panicum depauperatum	!
Dichanthelium dichotomum var. barbulatum	Panicum dichotomum var. barbulatum	Panicum dichotomum var. dichotomum in part	D. dichotomum var. dichotomum in part
Dichanthelium dichotomum var. dichotomum	Panicum dichotomum var. dichotomum	Panicum dichotomum var. dichotomum in part	D. dichotomum var. dichotomum in part
Dichanthelium dichotomum var. yadkinense	not included	!	D. dichotomum var. dichotomum in part
Dichanthelium implicatum	P. lanuginosum var. implicatum	P. acuminatum var. acuminatum in part	D. acuminatum var. fasciculatum in part
Dichanthelium joorii	not included	not included	D. commutatum in part
Dichanthelium lanuginosum	P. lanuginosum var. fasciculatum & P. subvillosum	P. acuminatum var. acuminatum in part	D. acuminatum var. fasciculatum in part
Dichanthelium latifolium	Panicum latifolium	Panicum latifolium	!
Dichanthelium laxiflorum	Panicum laxiflorum	Panicum laxiflorum	D. laxiflorum
Dichanthelium leibergii	Panicum leibergii	Panicum leibergii	!
Dichanthelium lindheimeri	P. lanuginosum var. lindheimeri & P. longiligulatum	P. acuminatum var. lindheimeri	D. acuminatum var. lindheimeri
Dichanthelium linearifolium var. linearifolium	Panicum linearifolium var. linearifolium	Panicum linearifolium in part	D. linearifolium in part
Dichanthelium longiligulatum	Panicum longiligulatum	(Dichanthelium acuminatum var. longiligulatum)	!
Dichanthelium malacophyllum	Panicum malacophyllum	Panicum malacophyllum	!
Dichanthelium microcarpon	Panicum microcarpon	P. dichotomum var. ramulosum	D. dichotomum var. dichotomum in part
Dichanthelium nitidum	Panicum nitidum	P. dichotomum var. nitidum	D. dichotomum var. dichotomum in part

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Dichanthelium oligosanthes var. oligosanthes	Panicum oligosanthes var. oligosanthes	Panicum oligosanthes var. oligosanthes	!
Dichanthelium oligosanthes var. scribnerianum	Panicum oligosanthes vars. helleri & scribnerianum	Panicum oligosanthes var. scribnerianum	D. oligosanthes var. scribnerianum
Dichanthelium perlongum	Panicum perlongum	P. linearifolium in part	D. linearifolium in part
Dichanthelium polyanthes	Panicum polyanthes	P. sphaerocarpon var. isophyllum	D. sphaerocarpon var. isophyllum
Dichanthelium praecocius	Panicum praecocius	P. acuminatum var. acuminatum in part	D. acuminatum var. praecocius
Dichanthelium ravenelii	Panicum ravenelii	Panicum ravenelii	!
Dichanthelium scoparium	Panicum scoparium	Panicum scoparium	!
Dichanthelium sphaerocarpon	Panicum sphaerocarpon incl. var. inflatum	Panicum sphaerocarpon var. sphaerocarpon	as var. sphaerocarpon
Dichanthelium villosissimum	Panicum villosissimum var. villosissimum	P. acuminatum var. acuminatum in part	as var. villosissimum
Dichanthelium werneri	Panicum linearifolium var. werneri	Panicum linearifolium in part	D. linearifolium in part
DICHELOSTEMMA CONGESTUM	not included	!	!
DICHONDRA CAROLINENSIS	not included	!	!
Dicliptera brachiata	!	!	!
DICTAMNUS ALBUS	not included	not included	!
Didiplis diandra	Peplis diandra	!	!
DIGITARIA CILIARIS	D. sanguinalis var. ciliaris	!	!
Digitaria cognata	Leptoloma cognatum	!	!
Digitaria filiformis	! incl. var. villosa	! incl. var. villosa	!
DIGITARIA ISCHAEMUM	! incl. var. mississippiensis	!	!
DIGITARIA SANGUINALIS	D. sanguinalis	!	!
DIGITARIA VIOLASCENS	not included	not included	!
Diodia teres	!	!	!
Diodia virginiana	!	!	!
DIOSCOREA OPPOSITIFOLIA	not included	!	!
Dioscorea quaternata	!	!	!
Dioscorea villosa	!	!	!
Diospyros virginiana	! incl. vars. platycarpa & pubescens	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Diplazium pycnocarpon	Athyrium pycnocarpon	!	!
DIPLOTAXIS MURALIS	not included	!	!
DIPSACUS FULLONUM	D. sylvestris	!	!
DIPSACUS LACINIATUS	not included	!	!
Dirca palustris	!	! incl. D. decipiens	!
Distichlis spicata var. spicata	D. spicata	!	incl. in D. spicata
DISTICHLIS SPICATA var. STRICTA	D. stricta	!	incl. in D. spicata
Doellingeria umbellata var. pubens	not included	!	!
Draba aprica	!	!	!
Draba brachycarpa	!	!	!
Draba cuneifolia	!	!	!
Draba reptans	! incl. var. micrantha	!	!
DRABA VERNA	! incl. var. boerhaavii	!	!
DRACOCEPHALUM PARVIFLORUM	!	!	!
Drymocallis arguta	Potentiall arguta	!	Potentilla arguta
Dryopteris carthusiana	D. austriaca var. spinulosa	!	!
Dryopteris celsa	D. clintoniana var. australis	!	!
Dryopteris cristata	not included	!	!
Dryopteris goldiana	!	!	!
Dryopteris intermedia	D. austriaca var. intermedia	!	!
Dryopteris marginalis	!	!	!
DUCHESNEA INDICA	!	!	!
Dulichium arundinaceum	!	!	!
Dyssodia papposa	!	!	!
Echinacea angustifolia	!	!	!
Echinacea pallida	! in part	!	!
Echinacea paradoxa	!	!	!
Echinacea purpurea	!	!	!
Echinacea simulata	E. pallida in part	!	!
ECHINOCHLOA COLONUM	!	!	E. "colona"
ECHINOCHLOA CRUSGALLI	! incl. var. frumentacea	!	!
ECHINOCHLOA CRUS-PAVONIS var. MACERA	not included	!	!
Echinochloa muricata	! incl. vars. ludoviciana, microstachya & occidentalis	! incl. var. microstachya	! incl. var. microstachya

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Echinochloa walteri	not included	!	!
Echinocystis lobata	!	!	!
Echinodorus berteroi	as var. lanceolatus	!	!
Echinodorus cordifolius	!	!	!
Echinodorus tenellus	as var. parvulus	as var. parvulus	!
ECHIUM VULGARE	!	!	!
Eclipta prostrata	E. alba	!	!
EGERIA DENSA	not included	!	!
EICHHORNIA CRASSIPES	!	!	!
ELAEAGNUS ANGUSTIFOLIA	!	!	!
ELAEAGNUS UMBELLATA	not included	!	!
Elatine triandra	as var. americana	! incl. var. americana	!
Eleocharis acicularis	!	!	!
Eleocharis atropurpurea	not included	!	!
Eleocharis compressa var. acutisquamata	E. compressa in part	E. compressa in part	!
Eleocharis compressa var. compressa	E. compressa in part	E. compressa in part	!
Eleocharis elliptica	not included	(!)	!
Eleocharis engelmannii	!	E. ovata in part	!
Eleocharis equisetoides	!	!	!
Eleocharis erythropoda	E. calva	!	!
Eleocharis lanceolata	!	!	!
Eleocharis macrostachya	E. macrostachya in part	E. palustris in part	E. macrostachya in part
Eleocharis obtusa	! in part, incl. var. jejuna	E. ovata in part	!
Eleocharis ovata	E. obtusa in part incl. var. jejuna	! in part	!
Eleocharis palustris	E. smallii	E. palustris in part	E. palustris in part
Eleocharis parvula	! incl. var. anachaeta	!	!
Eleocharis quadrangulata	!	!	!
Eleocharis tenuis var. atrata	not included	not included	E. compressa in part
Eleocharis verrucosa	E. tenuis var. verrucosa	!	E. tenuis var. verrucosa
Eleocharis wolfii	!	!	!
Eleocharis xyridiformis	E. macrostachya in part	E. palustris in part	E. macrostachya in part
Elephantopus carolinianus	!	!	!
ELEUSINE INDICA	!	!	!
ELEUSINE TRISTACHYA	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Ellisia nyctelea	!	!	!
Elodea canadensis	Anacharis canadensis	!	!
Elodea nuttallii	Anacharis nuttallii	!	!
Elymus canadensis	!	!	!
Elymus churchii	E. interruptus	E. diversiglumis	E. interruptus in part
Elymus curvatus	E. submuticus	E. virginicus var. submuticus	E. submuticus
ELYMUS ELONGATUS subsp. PONTICUS	not included	!	Thinopyrum ponticum
Elymus glabriflorus	E. virginicus var. glabriflorus in part	Elymus virginicus var. glabriflorus in part	! In part
Elymus glaucus	!	!	!
Elymus hystrix	Hystrix patula	!	! incl. var. bigloviana
Elymus jejunus	Elymus virginicus var. jejunus	E. virginicus var. virginicus in part	E. virginicus var. virginicus in part
ELYMUS LONGIFOLIUS	Sitanion longifolium	!	E. elymoides subsp. brevifolius
Elymus macgregorii	E. virginicus var. glabriflorus in part	not included	E. glabriflorus in part
ELYMUS REPENS	Agropyron repens var. subulatum	!	!
Elymus riparius	!	!	!
ELYMUS TRACHYCAULUS	Agropyron trachycaulum incl. var. glaucum	!	! incl. subsp. subsecundus
Elymus villosus	!	!	!
Elymus virginicus	as var. virginicus	! in part	! in part
ENGELMANNIA PERISTENIA	E. pinnatifida	!	!
Epifagus virginiana	!	!	!
EPILOBIUM CILIATUM	not included	!	!
Epilobium coloratum	!	!	!
Epilobium leptophyllum	!	!	!
EPIPACTIS HELLEBORINE	!	!	!
Equisetum × ferrissii	not included	!	!
Equisetum × nelsonii	not included	!	!
Equisetum arvense	!	!	!
Equisetum hyemale	as vars. elatum & pseudohyemale	as var. affine	!
Equisetum laevigatum	! incl. E. kansanum	!	!
ERAGROSTIS BARRELIERI	not included	!	!
Eragrostis capillaris	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
ERAGROSTIS CILIANENSIS	!	!	!
ERAGROSTIS CURTIPEDICELLATA	(!)	!	!
ERAGROSTIS CURVULA	!	!	!
ERAGROSTIS ELLIOTTII	not included	!	!
Eragrostis frankii	!	!	!
Eragrostis glomerata	!	!	E. japonica
Eragrostis hirsuta	!	!	!
Eragrostis hypnoides	!	!	!
Eragrostis intermedia	!	!	!
ERAGROSTIS MINOR	E. poaeoides	!	!
ERAGROSTIS PECTINACEA var. MISERRIMA	E. arida	!	!
Eragrostis pectinacea var. pectinacea	E. pectinacea	!	!
ERAGROSTIS PILOSA	!	!	in part
Eragrostis reptans	!	!	Neeragrostis reptans
ERAGROSTIS SECUNDIFLORA subsp. OXYLEPIS	not included	!	!
Eragrostis spectabilis	! incl. var. sparsihirsuta	!	!
Eragrostis trichodes	!	!	!
ERANTHUS HYEMALIS	not included	!	!
Erechtites hieracifolius	E. "hieracifolia"	!	!
Erianthus alopecuroides	!	!	Saccharum alopecurioides
ERIANTHUS GIGANTEUS	not included	!	Saccharum giganteum
ERIANTHUS RAVENNAE	!	!	Saccharum ravennae
Erianthus strictus	!	!	Saccharum baldwinii
Erigenia bulbosa	!	!	!
Erigeron annuus	!	!	!
Erigeron philadelphicus	!	!	!
Erigeron pulchellus	!	!	!
Erigeron strigosus	! incl. var. beyrichii	!	! incl. vars. beyrichii & septentrionalis
Erigeron tenuis	!	!	!
ERIOCHLOA ACUMINATA	E. gracilis	!	!
ERIOCHLOA CONTRACTA	!	!	!
ERIOCHLOA VILLOSA	not included	!	!
ERIOGONUM ANNUUM	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Eriogonum longifolium	!	!	!
ERODIUM CICUTARIUM	!	!	!
ERODIUM TEXANUM	!	!	!
ERUCA VESICARIA subsp. SATIVA	E. sativa	!	!
ERUCASTRUM GALLICUM	!	!	!
ERYNGIUM LEAVENWORTHII	(!)	!	!
Eryngium prostratum	!	!	!
Eryngium yuccifolium	!	!	!
Erysimum capitatum	!	!	!
ERYSIMUM CHEIRANTHOIDES	!	!	!
ERYSIMUM INCONSPICUUM	!	!	!
ERYSIMUM REPANDUM	!	!	!
Erythronium albidum	as var. albidum	!	!
Erythronium americanum	! in part	!	!
Erythronium mesochoreum	E. albidum var. mesochoreum	!	!
Erythronium rostratum	E. americanum in part	!	!
ESCHSCHOLTZIA CALIFORNICA	!	!	!
EUONYMUS ALATUS	not included	!	!
Euonymus americanus	!	!	!
Euonymus atropurpureus	!	!	!
EUONYMUS EUROPAEUS	not included	(!)	!
EUONYMUS HEDERACEUS	not included	!	E. fortunei var. radicans
Euonymus obovatus	!	!	!
Eupatorium album	not included	not included	!
Eupatorium altissimum	!	!	!
EUPATORIUM CAPILLIFOLIUM	!	!	!
Eupatorium fistulosum	!	!	Eutrochium fistulosum
Eupatorium hyssopifolium var. calcaratum	!	!	!
Eupatorium maculatum	not included	as var. bruneri	Eutrochium maculatum var. bruneri
Eupatorium perfoliatum	! incl. var. cuneatum	!	!
Eupatorium purpureum	!	! incl. var. holzingeri	Eutrochium purpureum, incl. var. holzingeri
Eupatorium rotundifolium	not included	as var. scabridum	as var. scabridum
Eupatorium semiserratum	E. cuneifolium var. semiserratum	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Eupatorium serotinum	!	!	!
Eupatorium sessilifolium	as var. brittonianum	!	! incl. var. brittonianum
Eupatorium torreyanum	not included	not included	E. hyssopifolium in part
Euphorbia commutata	!	!	!
Euphorbia corollata	! incl. vars. mollis & paniculata	!	!
Euphorbia cyathophora	E. heterophylla incl. var. graminifolia	!	!
EUPHORBIA CYPARISSIAS	!	!	!
Euphorbia davidii	E. dentata in part	!	!
Euphorbia dentata	! in part	!	!
EUPHORBIA ESULA	!	!	! Incl. var. uralensis
Euphorbia geyeri	!	!	Chamaesyce geyeri
Euphorbia glyptosperma	!	!	Chamaesyce glyptosperma
Euphorbia humistrata	!	!	Chamaesyce humistrata
Euphorbia maculata	E. supina	!	Chamaesyce maculata
Euphorbia marginata	!	!	!
Euphorbia missurica	!	!	Chamaesyce missurica
Euphorbia nutans	E. maculata	!	Chamaesyce nutans
Euphorbia obtusata	!	!	E. spathulata in part
EUPHORBIA OPTHALMICA	not included	not included	Chamaesyca opthalmica
Euphorbia ouachitana	not included	not included	not included
EUPHORBIA PROSTRATA	!	!	Chamaesyce prostrata
Euphorbia serpens	!	!	Chamaesyce serpens
EUPHORBIA SERPYLLIFOLIA	!	!	Chamaesyce serpyllifolia
Euphorbia spathulata	!	!	in part
EUPHORBIA STICTOSPORA	!	!	Chamaesyce stictiospora
Eurybia furcata	Aster furcatus	!	!
Eurybia hemispherica	Aster paludosus subsp. hemisphericus	!	!
Eurybia macrophylla	not included	!	!
Euthamia graminifolia	Solidago graminifolia vars. media & nuttallii	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Euthamia gymnospermoides	Solidago gymnospermoides	!	!
Euthamia leptocephala	Solidago leptocephala	!	!
EVOLVULUS ALSINOIDES	!	!	as var. angustifolius
Evolvulus nuttallianus	!	!	!
EXOCHORDA RACEMOSA	not included	!	!
FAGOPYRUM ESCULENTUM	F. sagittatum	!	!
Fagus grandifolia	as var. caroliniana	!	!
FALCARIA VULGARIS	F. sioides	!	!
FALLOPIA CONVOLVULUS	Polygonum convolvulus	!	Polygonum convolvulus
FALLOPIA DUMETORUM	Polygonum scandens in part, incl. var. cristatum	!	Polygonum scandens var. dumetorum
FALLOPIA JAPONICA	Polygonum cuspidatum	!	Polygonum cuspidatum
Fallopia scandens	Polygonum scandens in part, incl. var. cristatum	!	Polygonum scandens incl. var. cristatum
FATOUA VILLOSA	not included	!	!
FESTUCA ARUNDINACEA	F. elatior var. arundinacea	!	Schedonorus arundinaceus
FESTUCA OVINA	as var. ovina	!	!
Festuca paradoxa	!	!	!
FESTUCA PRATENSIS	F. elatior var. elatior	!	Schedonorus pratensis
FESTUCA RUBRA	! incl. vars. arenaria & commutata	!	! incl. subsp. arenaria
FESTUCA SORORIA	not included	!	!
Festuca subverticillata	F. obtusa	!	!
FESTUCA TRACHYPHYLLA	F. ovina var. duriuscula	!	F. brevipila
Filipendula rubra	!	!	!
Fimbristylis annua	F. dichotoma	!	!
Fimbristylis autumnalis	! incl. var. mucronulata	!	!
FIMBRISTYLIS LITTORALIS	not included	!	!
Fimbristylis puberula	F. caroliniana	!	!
Fimbristylis vahlii	!	!	!
FLAVERIA CAMPESTRIS	!	!	!
Fleischmannia incarnata	Eupatorium incarnatum	!	!
Floerkea proserpinacoides	!	!	!
FOENICULUM VULGARE	!	!	!
FONTANESIA PHILLYREOIDES subsp. FORTUNEI	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Forestiera acuminata	!	!	!
FORSYTHIA SUSPENSA	not included	!	!
FRAGARIA × ANANASSA	!	!	!
Fragaria vesca var. americana	!	!	!
Fragaria virginiana	! incl. var. illinoensis	!	! incl. var. grayana
Frasera caroliniensis	Swertia caroliniensis	!	!
Fraxinus americana	as. var. americana in part	!	F. americana in part
Fraxinus biltmoreana	F. americana var. biltmoreana	!	F. americana in part
Fraxinus pennsylvanica var. pennsylvanica	!	F. pennsylvanica in part	F. pennsylvanica in part
Fraxinus pennsylvanica var. subintegerrima	!	F. pennsylvanica in part	F. pennsylvanica in part
Fraxinus profunda	F. tomentosa	!	!
Fraxinus quadrangulata	!	!	!
Fraxinus smallii	F. americana var. americana in part	!	F. americana in part
Froelichia floridana var. campestris	!	!	!
Froelichia gracilis	!	!	!
Fuirena simplex var. aristatula	F. simplex in part	!	!
Fuirena simplex var. simplex	F. simplex in part	!	!
FUMARIA OFFICINALIS	not included	!	!
Gaillardia aestivalis var. flavovirens	G. lutea	!	!
GAILLARDIA PULCHELLA	!	!	!
Galactia regularis	G. volubilis var. missippiensis	!	!
GALANTHUS NIVALIS	not included	not included	!
Galearis spectabilis	Orchis spectabilis	!	!
GALEOPSIS TETRAHIT	!	!	!
GALINSOGA PARVIFLORA	!	!	!
GALINSOGA QUADRIRADIATA	G. ciliata	!	!
GALIUM ANGLICUM	not included	!	G. divaricatum in part
Galium aparine	!	!	!
Galium arkansanum	!	!	!
Galium asprellum	not included	!	!
Galium boreale	as var. hyssopifolium	!	!
Galium circaezans	! incl. var. hypomalicum	!	! incl. var. hypomalicum
Galium concinnum	!	!	!
GALIUM DIVARICATUM	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Galium obtusum	!	!	!
GALIUM PEDEMONTANUM	G. virgatum in part	!	Cruciata pedemontanum
Galium pilosum	!	!	! incl. var. puncticulosum
Galium tinctorium	!	!	!
Galium triflorum	!	!	!
GALIUM VERUM	!	!	!
Galium virgatum	in part	!	!
Gamochaeta argyrinea	Gnaphalium purpureum in part	!	Gnaphalium purpureum in part
GAMOCHAETA PENSYLVANICA	Gnaphalium purpureum in part	!	!
Gamochaeta purpurea	Gnaphalium purpureum in part	!	in part
Gaura coccinea	!	Oenothera suffrutescens	!
Gaura longiflora	Gaura biennis incl. var. pitcheri	Oenothers filiformis	!
Gaura parviflora	!	Oenothera curtiflora	!
GAURA SINUATA	not included	!	!
Gaylussacia baccata	!	!	!
Gentiana alba	Gentiana flavida	!	!
Gentiana andrewsii var. andrewsii	G. andrewsii	!	!
Gentiana andrewsii var. dakotica	C. clausa	!	!
Gentiana puberulenta	G. puberula	!	!
Gentianella quinquefolia subsp. occidentalis	Gentiana quinquefolia var. occidentalis	!	!
Geocarpon minimum	!	!	!
Geranium carolinianum	! incl. var. confertiflorum	!	!
GERANIUM COLUMBINUM	not included	!	!
GERANIUM DISSECTUM	!	!	!
Geranium maculatum	!	!	!
GERANIUM MOLLE	!	!	!
GERANIUM PUSILLUM	!	!	!
Geum canadense	! incl. var. camporum	!	!
Geum fragarioides	Waldsteinia fragarioides	!	Waldsteinia fragarioides
Geum laciniatum	as var. trichocarpum	!	as var. trichocarpum
Geum triflorum	not included	!	!
Geum vernum	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Geum virginianum	not included	!	!
Gillenia stipulata	!	!	!
Gillenia trifoliata	!	!	!
GLADIOLUS COMMUNIS	not included	not included	!
Glandularia bipinnatifida	!	!	!
Glandularia canadensis	!	!	!
GLECHOMA HEDERACEA	! incl. var. micrantha	!	!
Gleditsia aquatica	!	!	!
Gleditsia triacanthos	!	!	!
GLINUS LOTOIDES	!	!	!
Glyceria acutiflora	!	!	!
Glyceria septentrionalis var. arkansana	!	!	G. arkansana
Glyceria septentrionalis var. septentrionalis	!	!	G. spetentrionalis
Glyceria striata	! incl. var. stricta	!	!
GLYCINE MAX	!	!	!
Glycyrrhiza lepidota	!	!	!
Gonolobus suberosus	Matelea gonocarpa	!	Matelea gonocarpos
Goodyera pubescens	!	!	!
GOSSYPIUM HIRSUTUM	G. herbaceum	!	!
Gratiola neglecta	!	!	!
Gratiola virginiana	!	!	!
Gratiola viscidula	!	!	!
GRINDELIA CILIATA	Haplopappus ciliatus	!	G. papposa
Grindelia lanceolata	!	!	!
GRINDELIA SQUARROSA	! incl. vars. nuda & serrulata	! incl. vars. nuda & quasiperennis	! incl. G. nuda
GUIZOTIA ABYSSINICA	not included	!	!
GUTIERREZIA TEXANA	!	!	!
Gymnocladus dioica	!	!	G. "dioicus"
Gymnopogon ambiguus	!	!	!
Hackelia virginiana	!	!	!
HALESIA DIPTERA	not included	!	!
Hamamelis vernalis	!	!	!
Hamamelis virginiana	!	!	!
Hasteola suaveolens	Cacalia suaveolens	!	!
Hedeoma hispida	!	!	!
Hedeoma pulegioides	!	!	!
HEDERA HELIX	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
HELENIUM AMARUM	!	!	!
Helenium autumnale	! incl. vars. canaliculatum & parviflorum	!	!
Helenium flexuosum	!	!	!
Helenium virginicum	H. autumnale × H. flexuosum	!	!
Helianthemum bicknellii	!	!	!
Helianthemum canadense	(!)	!	!
Helianthus × laetiflorus	H. laetiflorus var. laetiflorus	!	!
Helianthus angustifolius	!	!	!
Helianthus annuus	! incl. vars. lenticularis & nanus	!	!
Helianthus decapetalus	!	!	!
Helianthus divaricatus	!	!	!
Helianthus grosseserratus	!	!	!
Helianthus hirsutus	! incl. vars. stenophyllus & trachyphyllus	!	!
Helianthus maximilianii	H. "maximiliani"	!	H. "maximiliani"
Helianthus microcephalus	!	!	!
Helianthus mollis	!	!	!
Helianthus occidentalis	!	!	!
Helianthus pauciflorus subsp. pauciflorus	H. laetiflorus var. rigidus	!	!
HELIANTHUS PAUCIFLORUS subsp. SUBRHOMBOIDEUS	not included	!	!
HELIANTHUS PETIOLARIS	!	!	!
Helianthus salicifolius	!	!	!
Helianthus silphioides	!	!	!
Helianthus strumosus	!	!	!
Helianthus tuberosus	! incl. var. subcanescens	!	!
Heliopsis helianthoides var. helianthoides	as var. occidentalis	!	! incl. var. occidentalis
Heliopsis helianthoides var. scabra	!	!	!
HELIOTROPIUM AMPLEXICAULE	not included	!	!
Heliotropium curassavicum	not included	!	!
HELIOTROPIUM INDICUM	!	!	!
HELIOTROPIUM PROCUMBENS	not included	!	!
Heliotropium tenellum	!	!	!
HELMINOTHECA ECHIOIDES	not included	!	Picris echioides

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
HEMEROCALLIS FULVA	! incl. var. kwanso	! incl. var. kwanso	!
Heracleum sphondylium subsp. montanum	H. maximum	!	H. maximum
HESPERIS MATRONALIS	!	!	!
Heteranthera dubia	!	!	!
Heteranthera limosa	!	!	!
Heteranthera multiflora	H. reneformis in part	!	!
Heteranthera reniformis	in part	!	!
Heteranthera rotundifolia	not included	!	!
Heterotheca camporum	Chrysopsis villosa var. camporum	! incl. var. glandulissimum	! incl. var. glandulissimum
Heterotheca canescens	Chrysopsis villosa vars. angustifolia & canescens	!	!
Heterotheca subaxillaris	H. latifolia	!	!
Heuchera americana	as vars. hirsuticaulis & interior	! incl. var. hirsuticaulis	! incl. var. hirsuticaulis
Heuchera parviflora var. parviflora	H. missouriensis	!	!
Heuchera parviflora var. puberula	H. puberula	!	!
Heuchera richardsonii	as vars. affinis & grayana	!	!
Heuchera villosa	as var. macrorhiza	!	!
Hexalectris spicata	!	!	!
Hibiscus laevis	H. militaris	!	!
Hibiscus lasiocarpos	!	!	!
HIBISCUS SYRIACUS	!	!	!
HIBISCUS TRIONUM	!	!	!
HIERACIUM CAESPITOSUM	not included	!	!
Hieracium gronovii	!	!	!
Hieracium longipilum	!	!	!
Hieracium scabrum	! incl. var. intonsum	!	! incl. var. intonsum
HOLCUS LANATUS	!	!	!
HOLOSTEUM UMBELLATUM	!	!	!
Hordeum jubatum	! incl. var. caespitosum	!	! incl. subsp. intermedium
Hordeum pusillum	!	!	!
HORDEUM VULGARE	! incl. var. trifurcatum	!	!
Hottonia inflata	!	!	!
Houstonia caerulea	!	!	!
Houstonia longifolia var. longifolia	!	H. longifolia in part	H. longifolia in part

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Houstonia longifolia var. tenuifolia	!	H. longifolia in part	H. longifolia in part
Houstonia micrantha	not included	!	!
Houstonia nigricans	!	!	Stenaria nigricans
Houstonia purpurea	! incl. var. calycosa	!	! incl. var. calycosa
Houstonia pusilla	Houstonia minima & Houstonia pusilla	!	!
Houstonia rosea	not included	!	!
HUMULUS JAPONICUS	!	!	!
Humulus lupulus var. lupulus	! in part	!	!
Humulus lupulus var. neomexicanus	! in part	!	!
Humulus lupulus var. pubescens	! in part	!	!
Huperzia lucidula	Lycopodium lucidulum	!	!
Huperzia porophila	Lycopodium selago var. patens	!	!
Hydrangea arborescens	! incl. vars. deamii & oblonga	! incl. subsp. discolor	!
Hydrastis canadensis	!	!	!
HYDRILLA VERTICILLATA	not included	not included	!
Hydrocotyle ranunculoides	not included	!	!
Hydrocotyle verticillata	!	!	!
Hydrolea ovata	!	!	!
Hydrolea uniflora	!	!	!
Hydrophyllum appendiculatum	!	!	!
Hydrophyllum canadense	!	!	!
Hydrophyllum virginianum	!	!	!
Hylodesmum glutinosim	Desmodium glutinosum	!	Desmodium glutinosum
Hylodesmum nudiflorum	Desmodium nudiflorum	!	Desmodium nudiflorum
Hylodesmum pauciflorum	Desmodium pauciflorum	!	Desmodium pauciflorum
Hymenocallis caroliniana	H. occidentalis	!	!
Hymenopappus scabiosaeus	!	!	!
Hypericum adpressum	not included	!	!
Hypericum ascyron subsp. pyramidatum	H. pyramidatum	!	H. ascyron
Hypericum drummondii	!	!	!
Hypericum gentianoides	!	!	!
Hypericum gymnanthum	!	!	!
Hypericum hypericoides	Ascyrum hypericoides var. hypericoides	as subsp. hypericoides	as subsp. hypericoides

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Hypericum lobocarpum	H. densiflorum incl. var. lobocarpum	!	!
Hypericum majus	H. canadense	!	!
Hypericum mutilum	! incl. var. parviflorum	!	!
HYPERICUM PERFORATUM	!	!	!
Hypericum prolificum	H. spathulatum	!	!
Hypericum pseudomaculatum	H. punctatum var. pseudomaculatum	!	!
Hypericum punctatum	as var. punctatum	!	!
Hypericum sphaerocarpum	! incl. var. turgidum	!	!
Hypericum strangulum	Ascyrum hypericoides var. multicaule	H. hypericoides subsp. multicaule	H. hypericoides subsp. multicaule
HYPOCHAERIS RADICATA	!	!	!
Hypoxis hirsuta	!	!	!
Ilex decidua	!	!	!
Ilex opaca	!	!	!
Ilex verticillata	as var. padifolia	as var. padifolia	!
ILEX VOMITORIA	not included	!	!
IMPATIENS BALSAMINEA	!	!	!
Impatiens capensis	!	!	!
Impatiens pallida	!	!	!
INULA BRITANNICA	not included	!	!
INULA HELENIUM	!	!	!
Iodanthus pinnatifidus	!	!	!
Ionactis linariifolius	Aster linariifolius	!	!
IPOMOEA AMNICOLA	!	!	!
IPOMOEA COCCINEA	!	!	!
IPOMOEA HEDERACEA	! incl. var. integriuscula	!	!
Ipomoea lacunosa	!	!	!
Ipomoea pandurata	!	!	!
IPOMOEA PURPUREA	!	!	!
IPOMOEA QUAMOCLIT	!	!	!
IPOMOEA TRICOLOR	not included	!	!
IPOMOPSIS RUBRA	Gilia rubra	!	!
Iresine rhizomatosa	!	!	!
Iris brevicaulis	!	!	!
Iris cristata	!	!	!
Iris fulva	!	!	!
IRIS GERMANICA	!	!	!
IRIS ORIENTALIS	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
IRIS PALLIDA	!	!	!
IRIS PSEUDOACORUS	!	!	!
IRIS PUMILA	!	!	!
IRIS VERNA	not included	!	!
Iris virginica var. shrevei	!	!	!
ISATIS TINCTORIA	(!)	!	!
Isoetes butleri	!	!	!
Isoetes engelmannii	!	!	!
Isoetes melanopoda	!	!	!
Isolepis carinata	Scirpus koilolepis	!	!
Isolepis molesta	not included	!	!
Isopyrum biternatum	!	!	Enemion biternatum
Isotria medeoloides	!	!	!
Isotria verticillata	!	!	!
Itea virginica	!	!	!
IVA ANGUSTIFOLIA	not included	not included	!
Iva annua	I. ciliata	!	! incl. vars. caudata & macrocarpa
JACQUEMONTIA TAMNIFOLIA	not included	!	!
JASMINUM NUDIFLORUM	not included	!	!
Juglans cinerea	!	!	!
Juglans nigra	!	!	!
Juncus acuminatus	!	!	!
Juncus alpinoarticulatus	J. alpinus var. fuscescens	!	as subsp. nodulosus
Juncus balticus subsp. littoralis	J. balticus var. littoralis	!	J. arcticus subsp. littoralis
Juncus biflorus	!	!	!
Juncus brachycarpus	!	!	!
Juncus brachyphyllus	J. kansanus	!	!
Juncus bufonius	!	!	!
Juncus canadensis	!	!	!
Juncus debilis	!	!	!
Juncus diffusissimus	!	!	!
Juncus dudleyi	!	!	!
Juncus effusus subsp. solutus	J. effusus var. solutus	!	as var. solutus
Juncus filipendulus	not included	not included	!
JUNCUS GERARDII	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Juncus interior	!	!	!
Juncus marginatus	! incl. var. setosus	!	!
Juncus nodatus	!	!	!
Juncus nodosus	!	!	!
Juncus scirpoides	!	!	!
Juncus secundus	!	!	!
Juncus subcaudatus	!	!	!
Juncus tenuis var. anthelatus	J. tenuis fs. anthelatus & discretiflorus	!	J. anthelatus
Juncus tenuis var. tenuis	J. tenuis f. tenuis	!	!
Juncus torreyi	!	!	!
Juncus validus	!	!	!
Juniperus ashei	!	!	!
Juniperus virginiana	!	!	!
Justicia americana	!	!	!
Justicia ovata	!	as var. lanceolata	as var. lanceolata
KALLSTROEMIA PARVIFLORA	K. hirsutissima	!	!
KICKXIA ELATINE	!	!	!
KICKXIA SPURIA	!	!	!
KNAUTIA ARVENSIS	not included	not included	!
KOCHIA SCOPARIA	! incl. vars. culta & pubescens	!	Bassia scoparia
Koeleria macrantha	K. cristata	!	!
KOELRUETERIA PANICULATA	not included	!	!
KOLKWITZIA AMABILIS	not included	not included	!
Krigia biflora	!	!	!
Krigia caespitosa	Serenia oppositifolia	!	!
Krigia dandelion	!	!	!
Krigia occidentalis	!	!	!
Krigia virginica	!	!	!
KUMMEROWIA STIPULACEA	Lespedeza stipulacea	!	!
KUMMEROWIA STRIATA	Lespedeza striata	!	!
KYLLINGA GRACILLIMA	not included	!	!
Kyllinga pumila	Cyperus tenuifolius	!	!
LABLAB PURPUREUS	not included	!	!
Lactuca canadensis	! incl. vars. latifolia, longifolia & obovata	!	!
Lactuca floridana	! incl. var. villosa	!	! incl. var. villosa
Lactuca hirsuta	! incl. var. sanguinea	!	! incl. var. sanguinea

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Lactuca ludoviciana	!	!	!
LACTUCA SALIGNA	!	!	!
LACTUCA SERRIOLA	L. scariola	!	!
Lactuca tatarica subsp. pulchella	L. pulchella	!	as var. pulchella
LAGENARIA SICERARIA	!	!	!
LAMIUM AMPLEXICAULE	!	!	!
LAMIUM HYBRIDUM	not included	!	L. purpureum var. incisum
LAMIUM PURPUREUM	!	!	!
Laportea canadensis	!	!	!
LAPPULA REDOWSKII	as var. occidentalis	!	L. occidentalis incl. var. cupulata
LAPPULA SQUARROSA	L. echinata	!	!
LAPSANA COMMUNIS	!	!	!
LATHYRUS HIRSUTUS	!	!	!
LATHYRUS LATIFOLIUS	!	!	!
Lathyrus palustris	! incl. var. myrtifolius	!	!
Lathyrus pusillus	!	!	!
LATHYRUS SYLVESTRIS	not included	!	!
LATHYRUS TUBEROSUS	not included	!	!
Lathyrus venosus	as var. intonsus	!	!
LAVATERA TRIMESTRIS	not included	!	!
Leavenworthia uniflora	!	!	!
Lechea mucronata	L. villosa	!	!
Lechea racemulosa	!	!	!
Lechea tenuifolia	!	!	!
Leersia lenticularis	!	!	!
Leersia oryzoides	!	!	!
Leersia virginica var. ovata	L. virginica in part	L. virginica in part	L. virginica in part
Leersia virginica var. virginica	L. virginica in part	L. virginica in part	L. virginica in part
Leitneria floridana	!	!	! incl. L. pilosa subsp. ozarkana
Lemna aequinoctialis	not included	!	!
Lemna minor	!	!	!
Lemna minuta	L. minima	!	!
Lemna obscura	not included	!	!
Lemna perpusilla	!	!	!
Lemna trisulca	!	!	!
Lemna turionifera	not included	!	!
Lemna valdiviana	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
LEONTODON TARAXACOIDES	not included	!	!
LEONURUS CARDIACA	!	!	!
LEONURUS JAPONICUS	L. sibiricus	!	L. sibiricus
LEONURUS MARRUBIASTRUM	not included	!	Chaiturus marrubiastrum
LEPIDIUM APPELIANUM	Cardaria pubescens var. elongata	!	Cardaria pubescens
LEPIDIUM CAMPESTRE	!	!	!
LEPIDIUM CHALAPENSE	Cardaria draba in part	!	Cardaria chalapensis
LEPIDIUM DENSIFLORUM	!	!	!
LEPIDIUM DIDYMUM	Coronopus didymus	!	Coronopus didymus
LEPIDIUM DRABA	Cardaria draba in part	!	Cardaria draba
LEPIDIUM LATIFOLIUM	not included	!	!
LEPIDIUM PERFOLIATUM	!	!	!
LEPIDIUM RUDERALE	not included	!	L. oblongum
Lepidium virginicum	!	!	!
LEPTOCHLOA DUBIA	not included	!	!
Leptochloa fusca subsp. fascicularis	Diplachne acuminata & D. fascicularis	!	!
LEPTOCHLOA FUSCA subsp. UNINERVIA	not included	!	!
Leptochloa panicea subsp. brachiata	L. filiformis var. filiformis	!	!
Leptochloa panicea subsp. mucronata	L. filiformis var. attenuata	!	!
Leptochloa panicoides	Diplachne halei	!	!
LESPEDEZA BICOLOR	not included	!	!
Lespedeza capitata	! incl. vars. stenophylla & vulgaris	!	!
LESPEDEZA CUNEATA	!	!	!
Lespedeza frutescens	L. violacea in part	! in part	! in part
Lespedeza hirta	!	as subsp. hirta	!
Lespedeza prairea	L. violacea in part	L. frutescens in part	L. frutescens in part
Lespedeza procumbens	! incl. var. elliptica	!	!
Lespedeza repens	!	!	!
Lespedeza stuevei	! incl. var. angustifolia	!	!
LESPEDEZA THUNBERGII	!	!	!
Lespedeza violacea	L. intermedia	!	!
Lespedeza virginica	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
LEUCANTHEMUM VULGARE	Chrysanthemum leucanthemum incl. var. pinnatifidum	!	!
LEUCOJUM AESTIVUM	!	!	! incl. spp. pulchellum
Leucospora multifida	Conobea multifida	!	!
LEVISTICUM OFFICINALE	L. paludapifolium	!	!
Liatris aspera	!	!	! incl. var. intermedia
Liatris cylindracea	!	!	!
Liatris mucronata	!	!	!
Liatris punctata	as var. nebraskana	!	as var. nebraskana
Liatris pycnostachya	!	!	!
Liatris scariosa var. nieuwlandii	L. ligulistylis	!	!
Liatris spicata	!	!	!
Liatris squarrosa var. hirsuta	!	!	!
Liatris squarrosa var. squarrosa	! incl. var. glabrata	! incl. var. glabrata	! incl. var. glabrata
Liatris squarrulosa	L. scabra	!	!
Ligusticum canadense	!	!	!
LIGUSTRUM OBTUSIFOLIUM	not included	!	!
LIGUSTRUM OVALIFOLIUM	!	!	!
LIGUSTRUM SINENSE	not included	!	!
LIGUSTRUM VULGARE	!	!	!
LILIUM LANCIFOLIUM	L. tigrinum	!	!
Lilium michiganense	!	!	!
Lilium philadelphicum var. andinum	not included	!	!
Lilium superbum	(!)	!	!
Limnobium spongia	!	!	!
Limnosciadium pinnatum	Cynosciadium pinnatum	!	!
LINARIA VULGARIS	!	!	!
Lindera benzoin	! incl. var. pubescens	!	! incl. var. pubescens
Lindera melissifolia	L. melissaefolium	!	!
Lindernia dubia var. anagallidea	L. anagallidea	L. dubia in part	!
Lindernia dubia var. dubia	L. dubia	L. dubia in part	!
Linum floridanum	not included	!	!
Linum medium var. texanum	!	!	!
LINUM RIGIDUM	!	! as var. compactum	L. compactum
Linum striatum	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Linum sulcatum	!	!	!
LINUM USITATISSIMUM	!	!	!
Linum virginianum	not included	!	!
Liparis liliifolia	!	!	!
Liparis loeselii	!	!	!
Lipocarpha aristulata	Hemicarpha drummondii in part	!	!
Lipocarpha drummondii	Hemicarpha drummondii in part	!	!
Lipocarpha micrantha	Hemicarpha micrantha	!	!
Lippia lanceolata	!	!	Phyla lanceolata
Lippia nodiflora	!	!	Phyla nodiflora
Liquidamber styraciflua	!	!	!
Liriodendron tulipifera	!	!	!
LIRIOPE MUSCARI	not included	not included	!
LIRIOPE SPICATA	not included	not included	!
Listera australis	not included	not included	!
Lithospermum canescens	!	!	!
Lithospermum carolinense	!	!	! incl. var. croceum
Lithospermum incisum	!	!	!
Lithospermum latifolium	!	!	!
Lobelia cardinalis	!	!	!
Lobelia inflata	!	!	!
Lobelia puberula	as var. mineolana	!	! incl. var. minneolana
Lobelia siphilitica	! incl. var. ludoviciana	!	! incl. var. ludoviciana
Lobelia spicata	! incl. vars. campanulata, hirtella & leptostachys	! incl. var. leptostachys	! incl. vars. campanulata, hirtella & leptostachys
LOBULARIA MARITIMA	not included	!	!
LOLIUM PERENNE var. ARISTATUM	L. multiflorum incl. var. diminutum	!	L. perenne subsp. multiflorum in part
LOLIUM PERENNE var. PERENNE	L. perenne	!	as subsp. perenne
LOLIUM PERSICUM	L. temulentum	!	!
LOLIUM RIGIDUM	L. temulentum var. macrochaeton	!	!
LOLIUM TEMULENTUM	not included (name as applied here conceptually refers to L. persicum & L. rigidum)	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Lomatium foeniculaceum	!	! incl. subsp. daucifolium	! incl. subsp. daucifolium
LONICERA × BELLA	L. morrowi	!	!
LONICERA × PERPUSII	not included	!	not included
Lonicera dioica	! incl. var. glaucescens	!	!
Lonicera flava	! incl. var. flavescens	!	!
LONICERA FRAGRANTISSIMA	not included	(!)	!
LONICERA JAPONICA	!	!	!
LONICERA MAACKII	not included	!	!
Lonicera reticulata	L. prolifera	!	!
LONICERA SEMPERVIRENS	!	!	!
LOTUS CORNICULATUS	!	!	!
Ludwigia alternifolia	! incl. var. pubescens	!	!
Ludwigia decurrens	Jussiaea decurrens	!	!
Ludwigia glandulosa	!	!	!
LUDWIGIA GRANDIFLORA	Jussiaea uruguayensis	!	!
Ludwigia leptocarpa	Jussiaea leptocarpa	!	!
Ludwigia linearis	not included	!	!
Ludwigia microcarpa	!	!	!
Ludwigia palustris	as vars. americana & nana	!	!
Ludwigia peploides subsp. glabrescens	Jussiaea repens var. glabrescens	!	!
Ludwigia polycarpa	!	!	!
LUNARIA ANNUA	not included	!	!
Luzula campestris var. bulbosa	L. bulbosa in part	!	L. bulbosa
Luzula campestris var. echinata	L. bulbosa in part	!	L. echinata
Luzula campestris var. multiflora	L. bulbosa in part	!	L. multiflora
LYCHNIS CORONARIA	not included	!	!
LYCIUM BARBARUM	L. halimifolium	!	!
LYCIUM CHINENSE	!	!	!
Lycopodium dendroideum	L. obscurum var. dendroideum	!	!
Lycopodium digitatum	not included	!	!
Lycopodium tristachyum	!	!	!
Lycopus americanus	! incl. var. longii	!	!
Lycopus asper	!	!	!
Lycopus rubellus	! incl. vars. arkansanus & lanceolatus	!	!
Lycopus uniflorus	not included	!	!
Lycopus virginicus	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Lygodesmia juncea	!	!	!
Lyonia mariana	!	!	!
Lysimachia ciliata	!	!	!
Lysimachia hybrida	!	!	!
Lysimachia lanceolata	!	!	!
LYSIMACHIA NUMMULARIA	!	!	!
Lysimachia quadriflora	!	!	!
Lysimachia radicans	!	!	!
Lysimachia terrestris	not included	!	!
Lysimachia thyrsiflora	!	!	!
LYSIMACHIA VULGARIS	not included	!	!
Lythrum alatum	!	! incl. var. lanceolatum	!
LYTHRUM SALICARIA	!	!	!
MACLURA POMIFERA	!	!	!
Magnolia acuminata	!	!	!
MAGNOLIA TRIPETALA	(!)	!	!
Maianthemum racemosum	Smilacina racemosa incl. var. cylindrata	!	!
Maianthemum stellatum	Smilacina stellata	!	!
Malaxis unifolia	!	!	!
MALUS × SOULARDII	Pyrus × soulardii	!	!
Malus angustifolia	Pyrus angustifolia var. spinosa	!	as var. puberula
MALUS BACCATA	not included	!	!
Malus coronaria	Pyrus coronaria incl. var. lancifolia	!	!
MALUS DOMESTICA	Pyrus malus	!	Malus pumila
MALUS FLORIBUNDA	not included	!	!
Malus ioensis	Pyrus ioensis	!	!
MALUS SIEBOLDII	not included	!	M. toringo
MALVA MOSCHATA	!	!	!
MALVA NEGLECTA	!	!	!
MALVA PARVIFLORA	!	!	!
MALVA PUSILLA	M. rotundifolia	!	!
MALVA SYLVESTRIS	!	!	!
MALVA VERTICILLATA	as var. crispa	as var. crispa	!
Malvastrum angustum	Sphaeralcea angusta	!	Malvastrum hispidum
Manfreda virginica	Agave virginica	!	!
MARRUBIUM VULGARE	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Marshallia caespitosa var. caespitosa	!	!	!
Marshallia caespitosa var. signata	!	!	!
MARSILEA MUTICA	not included	not included	!
MARSILEA QUADRIFOLIA	! incl. M. mucronata	!	!
Matelea baldwyniana	!	!	!
Matelea decipiens	! incl. M. obliqua	!	!
MATRICARIA CHAMOMILLA	!	!	M. recutita
MATRICARIA DISCOIDEA	M. matricarioides	!	!
Matteuccia struthiopteris var. pensylvanica	!	!	M. struthiopteris
MAZUS PUMILUS	M. japonicus	!	!
Mecardonia acuminata	Bacopa acuminata	!	!
Medeola virginiana	!	!	!
MEDICAGO ARABICA	!	!	!
MEDICAGO LUPULINA	! incl. var. glandulosa	!	!
MEDICAGO MINIMA	not included	!	!
MEDICAGO POLYMORPHA	as var. vulgaris	!	!
MEDICAGO SATIVA	!	!	!
MELAMPODIUM CINEREUM var. RAMOSISSIMUM	not included	!	!
Melanthium virginicum	!	!	Veratrum virginicum
MELIA AZEDARACH	!	!	!
Melica mutica	not included	not included	!
Melica nitens	!	!	!
MELILOTUS ALBUS	!	!	M. officinalis in part
MELILOTUS OFFICINALE	M. "officinalis"	!	M. "officinalis" in part
MELISSA OFFICINALIS	!	!	!
MELOCHIA CORCHORIFOLIA	not included	!	!
Melothria pendula	!	!	!
Menispermum canadense	!	!	!
MENTHA × GRACILIS	M. cardiaca; (M. gentilis)	!	!
MENTHA × PIPERITA	M. piperita & M. citrata	!	!
MENTHA AQUATICA var. CITRATA	not included	!	M. aquatica in part
Mentha canadensis	M. arvensis incl. var. villosa	!	M. arvensis
MENTHA LONGIFOLIA	as vars. mollissima & undulata	!	M. spicata in part

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
MENTHA SPICATA	!	!	! in part
MENTZELIA ALBESCENS	!	!	!
MENTZELIA NUDA	not included	!	!
Mentzelia oligosperma	!	!	!
Menyanthes trifoliata	as var. minor	!	!
Mertensia virginica	!	!	!
Micranthes pensylvanica var. forbesii	Saxifraga pensylvanica var. forbesii	!	S. pensylvanica in part
Micranthes texana	Saxifraga texana	Micranthes texana	Saxifraga texana
Micranthes virginiensis	Saxifraga virginiensis	Micranthes virginiensis	Saxifraga virginiensis
MICROSTEGIUM VIMINEUM	not included	!	!
MICROTHLASPI PERFOLIATUM	Thlaspa perfoliatum	!	!
Mikania scandens	!	!	!
Mimosa quadrivalvis var. nuttallii	Schrankia uncinata	!	M. nuttallii
Mimulus alatus	!	!	!
Mimulus glabratus	as var. fremontii	as var. jamesii	as var. jamesii
Mimulus ringens	! incl. var. minthodes	!	!
Minuartia michauxii	Arenaria stricta	!	! incl. var. texana
Minuartia muscorum	Arenaria patula var. robusta	!	!
Minuartia patula	Arenaria patula var. patula	!	!
Mirabilis albida	! incl. M. hirsuta	!	!
Mirabilis linearis	!	!	!
Mirabilis nyctaginea	!	!	!
MISCANTHUS SACCHARIFLORUS	not included	!	!
MISCANTHUS SINENSIS	M. floridulus	!	!
Mitchella repens	!	!	!
Mitella diphylla	!	!	!
Mitreola petiolata	Cynoctonum mitreola	!	!
Moehringia lateriflora	Arenaria lateriflora	!	!
MOLLUGO VERTICILLATA	!	!	!
Monarda bradburiana	M. russeliana	!	!
Monarda citriodora	!	!	!
Monarda clinopodia	!	!	!
MONARDA DIDYMA	!	!	!
Monarda fistulosa	! incl. var. mollis	!	!
MONARDA PECTINATA	!	!	!
Monarda punctata var. arkansana	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
MONARDA PUNCTATA var. OCCIDENTALIS	!	!	!
Monarda punctata var. villicaulis	!	!	!
MONOLEPIS NUTTALLIANA	!	!	!
Monotropa hypopitys	!	!	!
Monotropa uniflora	!	!	!
MORUS ALBA	!	!	!
Morus rubra	!	!	!
Muhlenbergia asperifolia	!	!	!
Muhlenbergia bushii	M. brachyphylla	!	!
Muhlenbergia capillaris	!	!	!
Muhlenbergia cuspidata	!	!	!
Muhlenbergia frondosa	!	!	!
Muhlenbergia glabrifloris	M. "glabriflora"	!	M. "glabriflora"
Muhlenbergia mexicana	!	!	!
Muhlenbergia racemosa	!	!	!
Muhlenbergia schreberi	! incl. var. curtisetosa	!	!
Muhlenbergia sobolifera	!	!	!
Muhlenbergia sylvatica	!	!	!
Muhlenbergia tenuiflora	!	!	!
MUSCARI BOTRYOIDES	!	!	!
MUSCARI COMOSUM	not included	!	!
MUSCARIA RACEMOSUM	not included	!	M. neglectum
Myosotis macrosperma	M. virginica var. macrosperma	!	!
MYOSOTIS SCORPIOIDES	!	!	!
MYOSOTIS STRICTA	not included	!	!
Myosotis verna	M. virginica var. virginica	!	!
MYOSOTON AQUATICUM	not included	!	!
Myosurus minimus	!	!	!
MYRIOPHYLLUM AQUATICUM	M. brasiliense	!	!
Myriophyllum heterophyllum	!	!	!
Myriophyllum pinnatum	!	!	!
MYRIOPHYLLUM SIBIRICUM	not included	!	!
MYRIOPHYLLUM SPICATUM	not included	!	!
Najas flexilis	!	!	!
Najas gracillima	!	!	!
Najas guadalupensis	!	!	!
NAJAS MINOR	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
NARCISSUS POETICUS	!	!	!
NARCISSUS PSEUDO-NARCISSUS	!	!	!
NASTURTIUM OFFICINALE	! incl. var. siifolium	!	!
Nelumbo lutea	!	!	!
NELUMBO NUCIFERA	!	!	!
Nemastylis geminiflora	!	!	!
Nemastylis nuttallii	!	!	!
NEPETA CATARIA	!	!	!
NESLIA PANICULATA	!	!	!
Neviusia alabamensis	!	!	!
NICANDRA PHYSALODES	!	!	!
NICOTIANA LONGIFLORA	!	!	!
NICOTIANA RUSTICA	!	!	!
NICOTIANA TABACUM	(!)	!	!
Nothocalis cuspidata	Agoseris cuspidata	!	!
Nothoscordum bivalve	!	!	!
Nuphar advena subsp. advena	Nuphar luteum subsp. macrophyllum	!	N. lutea subsp. advena in part
Nuphar advena subsp. ozarkana	Nuphar luteum subsp. ozarkanum	!	N. lutea subsp. advena in part
Nuttallanthus canadensis	Linaria canadensis var. canadensis	!	!
Nuttallanthus texanus	Linaria canadensis var. texana	!	!
Nymphaea odorata	! incl. var. gigantea & N. tuberosa	!	! incl. subsp. tuberosa
NYMPHOIDES PELTATA	N. "peltatum"	!	!
Nyssa aquatica	!	!	!
Nyssa biflora	not included	!	!
Nyssa sylvatica	! incl. var. caroliniana	!	!
Obolaria virginica	!	!	!
OCIMUM BASILICUM	!	!	!
OENANTHE JAVANICA	not included	!	!
Oenothera biennis	! incl. vars. hirsutissima & pycnocarpa	!	!
Oenothera clelandii	O. rhombipetala in part	!	!
Oenothera fruticosa subsp. fruticosa	as var. linearis	!	!
Oenothera fruticosa subsp. glauca	O. fruticosa var. hybrida	!	!
Oenothera grandis	O. laciniata var. grandiflora	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
OENOTHERA HETEROPHYLLA	not included	!	!
Oenothera laciniata	as var. laciniata	!	!
Oenothera linifolia	!	!	!
Oenothera macrocarpa	O. missouriensis	!	!
Oenothera nutans	not included	!	!
Oenothera parviflora	not included	!	!
Oenothera perennis	!	!	!
Oenothera pilosella	!	!	!
Oenothera rhombipetala	in part	!	!
Oenothera speciosa	! incl. O. kunthiana	!	!
Oenothera triloba	!	!	!
Oenothera villosa	O. biennis var. canescens	!	!
Oldenlandia boscii	!	!	!
Oldenlandia uniflora	!	!	!
Oligoneuron album	Aster ptarmicoides	Solidago ptarmicoides	!
Oligoneuron riddellii	Solidago riddellii	Solidago riddellii	!
Oligoneuron rigidum	Solidago rigida	Solidago rigida,incl. subsp. glabrata & humilis	! incl. vars. glabratum & humile
Onoclea sensibilis	!	!	!
ONOPORDUM ACANTHIUM	!	!	!
Onosmodium molle subsp. hispidissimum	O. hispidissimum	!	O. bejariense var. hispidissimum
Onosmodium molle subsp. occidentale	O. occidentale	!	O. bejariense var. occidentale
Onosmodium molle subsp. subsetosum	O. subsetosum	!	O. bejariense var. subsetorum
Ophioglossum crotalophoroides	not included	!	!
Ophioglossum engelmannii	!	!	!
Ophioglossum petiolatum	not included	!	!
Ophioglossum vulgatum	as vars. pycnostichum & pseudopodum	!	!
Opuntia humifusa	O. compressa	!	!
Opuntia macrorhiza	!	!	!
Opuntia polyacantha	(!)	!	!
Orbexilum onobrychis	Psoralea onobrychis	!	!
Orbexilum pedunculatum	Psoralea psoralioides var. eglandulosa	!	!
ORIGANUM VULGARE	not included	!	!
ORNITHOGALUM NUTANS	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
ORNITHOGALUM UMBELLATUM	!	!	!
Orobanche ludoviciana	!	!	as subsp. ludoviciana
Orobanche riparia	not included	!	!
Orobanche uniflora	!	!	!
ORYZA SATIVA	!	!	!
Oryzopsis racemosa	!	!	Patis racemosa
Osmorhiza claytonii	O. "claytoni"	!	!
Osmorhiza longistylis	! incl. vars. brachycoma & villicaulis	!	!
Osmunda cinnamomea	!	!	!
Osmunda claytoniana	!	!	!
Osmunda regalis var. spectabilis	!	!	!
Ostrya virginiana	! incl. var. lasia	!	!
OTTELIA ALISMOIDES	not included	not included	!
OXALIS CORNICULATA	!	!	!
Oxalis dillenii	as subsp. dillenii	!	! in part
Oxalis florida	O. dillenii subsp. filipes	!	O. dillenii in part
Oxalis stricta	!	!	!
Oxalis violacea	! incl. var. trichophora	!	!
Oxypolis rigidior	! incl. var. ambigua	!	!
Oxytropis lambertii	!	!	!
PACHYSANDRA PROCUMBENS	not included	!	!
Packera aurea	Senecio aureus incl. vars. gracilis & intercursus	!	!
Packera glabella	Senecio glabellus	!	!
Packera obovata	Senecio obovatus	!	!
Packera paupercula	Senecio pauperculus var. balsamitae	!	!
Packera plattensis	Senecio plattensis	!	!
Packera pseudaurea var. semicordata	Senecio aureus var. semicordatus	!	!
Packera tomentosa	not included	!	!
Palafoxia callosa	!	!	!
Panax quinquefolius	!	!	!
Panicum anceps	!	!	!
Panicum capillare	! incl. var. occidentale	!	!
Panicum dichotomiflorum	! incl. var. geniculatum	!	!
Panicum flexile	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Panicum gattingeri	!	P. philadelphicum in part	!
Panicum longifolium	P. rigidulum in part	P. rigidulum in part	P. rigidulum in part
PANICUM MILIACEUM	!	!	!
PANICUM OBTUSUM	!	!	!
Panicum philadelphicum	! incl. var. tuckermanii	! in part	!
Panicum rigidulum	P. agrostoides in part, incl. vars. condensum & ramosius, & P. stipitatum	! in part	! in part, incl. var. elongatum
Panicum verrucosum	not included	!	!
Panicum virgatum	!	!	!
PAPAVER DUBIUM	!	!	!
PAPAVER RHOEAS	!	!	!
PAPAVER SOMNIFERUM	!	!	!
Parietaria pensylvanica	!	!	!
Parnassia grandifolia	!	!	!
Paronychia canadensis	!	!	!
Paronychia fastigiata	! incl. var. paleacea	!	! incl. var. paleacea
Paronychia virginica	not included	!	!
Parthenium hispidum	!	Parthenium integrifolium var. hispidum	!
PARTHENIUM HYSTEROPHORUS	!	!	!
Parthenium integrifolium	!	Parthenium integrifolium var. integrifolium	!
Parthenocissus quinquefolia	!	!	!
PARTHENOCISSUS TRICUSPIDATA	not included	!	!
Parthenocissus vitacea	P. inserta	!	!
Pascopyrum smithii	Agropyron smithii	Elymus smithii	!
PASPALIDIUM GEMINATUM	Panicum geminatum	!	!
Paspalum bifidum	not included	!	!
PASPALUM DILATATUM	!	!	!
Paspalum dissectum	!	!	!
PASPALUM DISTICHUM	not included	!	!
Paspalum floridanum	! incl. var. glabratum	! incl. var. glabratum	!
Paspalum laeve var. circulare	! incl. var. pilosum	! incl. var. pilosum	P. laeve in part
Paspalum laeve var. laeve	!	!	! in part

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Paspalum pubiflorum	as var. glabrum	as var. glabrum	!
Paspalum repens	P. fluitans	!	P. fluitans
Paspalum setaceum var. ciliatifolium	P. ciliatifolium var. ciliatifolium	!	P. setaceum in part
Paspalum setaceum var. muhlenbergii	P. ciliatifolium var. muhlenbergii	!	P. setaceum in part
Paspalum setaceum var. setaceum	!	!	P. setaceum in part
Paspalum setaceum var. stramineum	P. ciliatifolium var. stramineum & P. bushii	!	P. setaceum in part
PASPALUM URVILLEI	!	!	!
Passiflora incarnata	!	!	!
Passiflora lutea	as var. glabriflora	as var. glabriflora	!
PASTINACA SATIVA	!	!	!
PAULOWNIA TOMENTOSA	!	!	!
Pedicularis canadensis	!	!	!
Pedicularis lanceolata	!	!	!
Pediomelum argophyllum	Psoralea argyphylla	!	!
Pediomelum esculentum	Psoralea esculenta	!	!
Pediomelum tenuiflorum	Psoralea tenuiflora incl. var. floribunda	!	Psoralidium tenuiflorum
Pellaea × gastonyi	not included	P. gastonyi	P. gastonyi
Pellaea atropurpurea	!	!	!
Pellaea glabella	!	! incl. var. missouriensis	! incl. subsp. missouriensis
Peltandra virginica	!	!	!
PENNISETUM ALOPECUROIDES	not included	(!)	!
PENNISETUM AMERICANUM	not included	!	P. glaucum
PENNISETUM SETACEUM	not included	not included	!
Penstemon arkansanus	!	!	!
Penstemon cobaea var. cobaea	!	P. cobaea in part	P. cobara in part
Penstemon cobaea var. purpureus	!	P. cobaea in part	P. cobaea in part
Penstemon digitalis	! incl. P. alluviorum	!	!
Penstemon grandiflorus	!	!	!
Penstemon pallidus	!	!	!
Penstemon tenuis	not included	!	!
Penstemon tubaeflorus	!	!	!
Penthorum sedoides	!	!	!
Perideridia americana	!	!	!
PERILLA FRUTESCENS	! incl. var. crispa	!	! incl. var. crispa

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Persicaria amphibia var. emersa	Polygonum coccineum incl. var. pratincola	!	Polygonum amphibium var. emersum
Persicaria amphibia var. stipulacea	Polygonum amphibium var. stipulaceum	!	Polygonum amphibium var. stipulaceum
Persicaria arifolia	Polygonum arifolium var. pubescens	!	Polygonum arifolium
Persicaria bicornis	Polygonum bicorne	!	Polygonum pensylvanicum in part
Persicaria glabra	Polygonum densiflorum	!	Polygonum glabrum
Persicaria hydropiper	Polygonum hydropiper	!	Polygonum hydropiper
Persicaria hydropiperoides	Polygonum hydropiperoides incl. var. opelousanum	!	Polygonum hydropiperoides
Persicaria lapathifolia	Polygonum lapathifolium	!	Polygonum lapathifolium
PERSICARIA LONGISETA	Polygonum caespitosum var. longisetum	!	Polygonum caespitosum
PERSICARIA MACULOSA	Polygonum persicaria	!	Polygonum persicaria
PERSICARIA ORIENTALIS	Polygonum orientale	!	Polygonum orientale
Persicaria pensylvanica	Polygonum pensylvanicum incl. vars. eglandulosum & laevigatum	!	Polygonum pensylvanicum in part
Persicaria punctata	Polygonum punctatum incl. var. majus in part & var. confertiflorum	!	Polygonum punctatum incl. var. confertiflorum
Persicaria robustior	Polygonum punctatum var. majus in part	!	Polygonum robustius
Persicaria sagittata	Polygonum sagittatum	!	Polygonum sagittatum
Persicaria setacea	Polygonum hydropiperoides var. setaceum	!	Polygonum setaceum
Persicaria virginiana	Polygonum virginianum incl. var. glaberrimum	!	Polygonum virginianum
PETROHAGIA PROLIFERA	Dianthus prolifer	!	!
PETUNIA × ATKINSIANA	(P. × hybrida)	!	!
PETUNIA AXILLARIS	!	!	!
PETUNIA INTEGRIFOLIA	P. violacea	!	!
Phacelia bipinnatifida	!	!	!
Phacelia covillei	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Phacelia gilioides	!	!	!
Phacelia hirsuta	!	!	!
Phacelia purshii	!	!	!
Phacelia ranunculacea	!	!	!
PHALARIS ARUNDINACEA	!	!	!
PHALARIS BRACHYSTACHYS	!	!	!
PHALARIS CANARIENSIS	!	!	!
Phalaris caroliniana	!	!	!
PHASEOLUS LUNATUS	as var. lunonanus	!	!
Phaseolus polystachios	!	!	!
PHASEOLUS VULGARIS	as var. humilis	!	!
Phegoteris hexagonoptera	Thelypteris hexagonoptera	!	!
PHELLODENDRON AMURENSE	not included	!	!
Phemeranthus calycinus	Talinum calycinum	!	!
Phemeranthus parviflorus	Talinum parviflorum	!	!
PHILADELPHUS CORONARIUS	not included	!	!
Philadelphus pubescens var. verrucosus	!	!	P. pubescens var. pubescens
PHLEUM PRATENSE	!	!	!
Phlox amplifolia	!	!	!
Phlox bifida	! incl. var. stellaria	!	! incl. var. stellaria
Phlox divaricata	as var. laphamii	!	! incl. subsp. laphamii
PHLOX DRUMMONDII	!	!	!
Phlox glaberrima subsp. interior	as var. interior & P. carolina	!	!
Phlox maculata subsp. pyramidalis	as var. pyramidalis	!	!
Phlox paniculata	!	!	!
Phlox pilosa subsp. fulgida	as var. fulgida	!	!
Phlox pilosa subsp. ozarkana	as var. ozarkana	!	!
Phlox pilosa subsp. pilosa	as var. pilosa, incl. var. amplexicaulis	!	!
PHLOX SUBULATA	(!)	!	!
Phoradendron leucarpum	P. flavescens	!	!
Phragmites australis subsp. americanus	P. communis var. berlandieri in part	P. australis in part	!
PHRAGMITES AUSTRALIS subsp. AUSTRALIS	P. communis var. berlandieri in part	P. australis in part	!
Phryma leptostachya	!	!	!
Phyllanthus carolinensis	!	!	!
Phyllanthus polygonoides	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
PHYLLOSTACHYS VIRIDIS	not included	not included	P. sulphurea
PHYSALIS ACUTIFOLIA	not included	!	!
PHYSALIS ALKEKENGI	not included	!	!
Physalis angulata	! incl. var. pendula	!	! incl. var. pendula
PHYSALIS CINERASCENS	P. viscosa subsp. mollis var. cinerascens	!	!
Physalis cordata	P. pubescens var. glabra	!	!
Physalis grisea	P. pubescens var. grisea	!	!
Physalis heterophylla	!	!	!
Physalis longifolia	as var. subglabrata	! incl. var. subglabrata	! incl. var. subglabrata
Physalis missouriensis	!	!	!
PHYSALIS PHILADELPHICA	P. ixocarpa	!	as var. immaculata
Physalis pubescens	! incl. vars. glabra (in part) & integrifolia	!	! incl. var. integrifolia
Physalis pumila	!	! incl. subsp. hispida	!
Physalis virginiana	!	!	!
Physaria filiformis	Lesquerella filiformis	!	Lesquerella filiformis
PHYSARIA GRACILIS	Lesquerella gracilis	!	Lesquerella gracilis
Physocarpus opulifolius var. intermedius	!	!	!
Physostegia angustifolia	!	!	!
Physostegia intermedia	!	!	!
Physostegia virginiana subsp. praemorsa	P. virginiana var. virginiana f. virginiana, P. virginiana var. speciosa, P. formosior	!	!
Physostegia virginiana subsp. virginiana	P. virginiana var. virginiana f. candida	!	!
Phytolacca americana	!	!	!
PICRIS HIERACIOIDES	not included	!	!
PICRIS RHAGADIOLOIDES	P. sprengeriana	!	P. spregeriana
Pilea pumila	!	!	!
Pilularia americana	not included	!	!
PINUS BANKSIANA	not included	!	!
Pinus echinata	!	!	!
PINUS NIGRA	!	!	!
PINUS STROBUS	not included	!	!
PINUS TAEDA	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
PINUS VIRGINIANA	!	!	!
PISTIA STRATIOTES	not included	not included	!
PISUM SATIVUM	!	!	!
Planera aquatica	!	!	!
Planodes virginica	Sibara virginica	!	Sibara virginica
Plantago aristata	!	!	!
Plantago cordata	!	!	!
Plantago elongata	P. pusilla incl. var. major	!	P. pusilla, incl. var. major
Plantago heterophylla	!	!	!
PLANTAGO INDICA	not included	!	P. psyllium
PLANTAGO LANCEOLATA	! incl. var. sphaerostachya	!	!
PLANTAGO MAJOR	!	!	!
Plantago patagonica	P. purshii & P. spinulosa	!	!
PLANTAGO RHODOSPERMA	!	!	!
Plantago rugelii	!	!	!
Plantago virginica	!	!	!
PLANTAGO WRIGHTIANA	!	!	!
Platanthera ciliaris	Habenaria ciliaris	!	!
Platanthera clavellata	Habenaria clavellata	!	!
Platanthera flava var. flava	Habenaria flava var. flava	!	!
Platanthera flava var. herbiola	Habenaria flava var. herbiola	!	!
Platanthera lacera	Habenaria lacera	!	!
Platanthera leucophaea	Habenaria leucophaea in part	!	!
Platanthera peramoena	Habenaria paramoena	!	!
Platanthera praeclara	Habenaria leucophaea in part	!	!
Platanthera psychodes	Habenaria psycodes	!	!
Platanus occidentalis	! incl. var. glabrata	!	!
Pluchea camphorata	!	!	!
Pluchea foetida	!	!	!
POA ANNUA	!	!	!
POA BULBOSA	!	!	!
Poa chapmaniana	!	!	!
POA COMPRESSA	!	!	!
Poa interior	not included	!	P. nemoralis subsp. interior

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
POA PALUSTRIS	!	!	!
POA PRATENSIS	!	!	!
Poa sylvestris	!	!	!
POA TRIVIALIS	!	!	!
Poa wolfii	!	!	!
Podophyllum peltatum	!	!	!
Pogonia ophioglossoides	!	!	!
Polanisia dodecandra subsp. dodecandra	P. dodecandra var. dodecandra	!	!
Polanisia dodecandra subsp. trachysperma	P. dodecandra var. trachysperma	!	!
Polemonium reptans	!	!	!
Polygala incarnata	!	!	!
Polygala sanguinea	!	!	!
Polygala senega	! incl. var. latifolia	!	!
Polygala verticillata	! incl. vars. ambigua, dolichoptera, isocycla & phenostachya	! incl. var. ambigua	! incl. var. isocycla & P. ambigua
Polygonatum biflorum var. commutatum	P. biflorum & P. canaliculatum	!	!
Polygonum achoreum	!	!	!
Polygonum americanum	Polygonella americana	!	Polygonella americana
POLYGONUM AVICULARE subsp. AVICULARE	in part, incl. var. vegetum in part	!	!
Polygonum aviculare subsp. buxiforme	P. aviculare var. littorale	!	P. buxiforme
POLYGONUM AVICULARE subsp. DEPRESSUM	in part, incl. var. vegetum in part	!	Polygonum arenastrum
POLYGONUM AVICULARE subsp. NEGLECTUM	in part, incl. var. vegetum in part	!	P. bellardii
Polygonum erectum	!	!	!
Polygonum ramosissimum var. prolificum	P. prolificum	P. ramosissimum in part	!
Polygonum ramosissimum var. ramosissimum	!	P. ramosissimum in part	!
Polygonum tenue	!	!	!
Polymnia canadensis	!	!	!
Polymnia laevigata	!	!	!
Polypodium polypodioides var. michauxianum	!	!	Pleopeltis polypodioides var. michauxiana
Polypodium virginianum	P. vulgare var. virginianum	!	!
Polypremum procumbens	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Polystichum acrostichoides	!	!	!
Polytaenia nuttallii	!	!	!
POMARIA JAMESII	Hoffmanseggia jamesii	!	!
Pontederia cordata	!	!	!
POPULUS × CANADENSIS	P. × eugenei	!	!
POPULUS × CANESCENS	P. tremula	!	!
POPULUS × JACKII	P. × gileadensis	!	!
POPULUS ALBA	!	!	!
Populus deltoides	! incl. var. missouriensis	! incl. subsp. monilifera	! incl. subsp. monilifera
Populus grandidentata	!	!	!
Populus heterophylla	!	!	!
POPULUS NIGRA var. ITALICA	!	!	P. nigra in part
Populus tremuloides	!	!	!
PORTULACA GRANDIFLORA	!	!	!
Portulaca pilosa	P. mundula	!	!
Portulacca oleracea	! incl. P. neglecta & P. retusa	!	!
Potamogeton amplifolius	!	!	!
POTAMOGETON CRISPUS	!	!	!
Potamogeton diversifolius	!	!	!
Potamogeton epihydrus	as var. nutallii	!	!
Potamogeton foliosus	! incl. var. macellus	!	!
Potamogeton illinoensis	!	!	!
Potamogeton nodosus	!	!	!
Potamogeton pectinatus	!	!	Stuckenia pectinata
Potamogeton pulcher	!	!	!
Potamogeton pusillus	!	!	! incl. subsp. tenuissimus
POTENTILLA ARGENTEA	not included	!	!
Potentilla canadensis	as var. villosissima	!	! incl. var. vilosissima
Potentilla norvegica	!	!	as subsp. monospeliensis
POTENTILLA RECTA	!	!	!
Potentilla rivalis	! incl. vars. millegrana & pentandra	!	!
Potentilla simplex	! incl. vars. argyrisma & calvescens	!	!
Potentilla supina subsp. paradoxa	P. nicollettii & P. paradoxa	!	P. paradoxa
Prenanthes alba	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Prenanthes altissima	as var. cinnamomea	!	!
Prenanthes aspera	!	!	!
Prenanthes crepidinea	!	!	!
Prenanthes racemosa	!	!	! incl. var. multiflora
Primula fassettii	Dodecatheon amethystinum	!	Dodecatheon amethystinum
Primula frenchii	not included	!	Dodecatheon frenchii
Primula meadia	Dodecatheon meadia incl. var. brachycarpum	!	Dodecatheon meadia incl. subsp. brachycarpum
PRIMULA VERIS	not included	!	!
PROBOSCIDEA LOUISIANA	P. "louisianica"	!	P. "louisianica"
Proserpinaca palustris	! incl. vars. amblyogona & crebra	! incl. vars. amblyogona & crebra	! incl. vars. amblyogona & crebra
PROSOPIS GLANDULOSA	not included	!	as var. torreyana
Prunella vulgaris var. lanceolata	!	!	as subsp. lanceolata
PRUNELLA VULGARIS var. VULGARIS	!	!	as subsp. vulgaris
Prunus americana	!	!	!
Prunus angustifolia	!	!	!
PRUNUS ARMENIACA	not included	!	!
PRUNUS CERASUS	!	!	!
Prunus hortulana	! incl. P. munsoniana	in part	! incl. P. munsoniana
PRUNUS MAHALEB	!	!	!
Prunus mexicana	!	!	!
Prunus munsoniana	!	P. hortulana in part	!
PRUNUS PERSICA	!	!	!
Prunus serotina	!	!	!
PRUNUS SPINOSA	!	!	!
Prunus virginiana	!	!	!
Pseudognaphalium helleri	not included	!	as subsp. helleri
Pseudognaphalium micradenium	Gnaphalium obtusifolium var. micradenium	!	P. helleri subsp. micradenium
Pseudognaphalium obtusifolium	Gnaphalium obtusifolium var. obtusifolium	!	!
Ptelea trifoliata	! incl. var. mollis	!	! incl. var. mollis

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Pteridium aquilinum	as vars. latiusculum & pseudocaudatum	as vars. latiusculum & pseudocaudatum	as vars. latiusculum & pseudocaudatum
Ptilimnium capillaceum	!	!	!
Ptilimnium costatum	!	!	!
Ptilimnium nuttallii	!	!	!
PUCCINELLIA DISTANS	! incl. P. airoides	!	!
PUERARIA MONTANA var. LOBATA	P. lobata	!	!
Pycnanthemum albescens	!	!	!
Pycnanthemum muticum	!	!	!
Pycnanthemum pilosum	!	!	P. verticillatum var. pilosum
Pycnanthemum tenuifolium	!	!	!
Pycnanthemum torrei	!	!	!
Pycnanthemum virginianum	!	!	!
PYRACANTHA COCCINEA	not included	!	!
Pyrrhopappus carolinianus	!	!	!
PYRUS CALLERYANA	not included	!	!
PYRUS COMMUNIS	!	!	!
QUERCUS ACUTISSIMA	not included	!	!
Quercus alba	!	!	!
Quercus bicolor	!	!	!
Quercus coccinea	! incl. var. tuberculata	!	! incl. var. tuberculata
Quercus ellipsoidalis	!	!	!
Quercus falcata	as var. falcata	!	!
Quercus imbricaria	!	!	!
Quercus lyrata	!	!	!
Quercus macrocarpa	!	!	! incl. var. depressa
Quercus marilandica	!	!	!
Quercus michauxii	!	!	!
Quercus muehlenbergii	Q. prinoides var. acuminata	!	!
Quercus nigra	!	!	!
Quercus pagoda	Q. falcata var. pagodaefolia	!	!
Quercus palustris	!	!	!
Quercus phellos	!	!	!
Quercus prinoides	as var. prinoides	!	!
Quercus rubra	! incl. var. borealis	!	! incl.var. ambigua

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Quercus shumardii var. acerifolia	Q. shumardii var. schneckii	Q. shumardii in part	Q. shumardii var. schneckii
Quercus shumardii var. shumardii	!	Q. shumardii in part	!
Quercus similis	not included	(!)	!
Quercus stellata	! incl. var. margaretta	as var. stellata	!
Quercus texana	Q. nutallii	!	!
Quercus velutina	!	!	!
Ranunculus abortivus	! incl. var. indivisus	!	!
RANUNCULUS ACRIS	!	!	!
Ranunculus aquatilis var. diffusus	R. longirostris	!	R. longirostris
RANUNCULUS ARVENSIS	!	!	!
RANUNCULUS BULBOSUS	!	!	!
Ranunculus cymbalaria	!	!	!
Ranunculus fascicularis	! incl. var. apricus	!	!
RANUNCULUS FICARIA	not included	as subsp. bulbifer	as var. bulbifera
Ranunculus flabellaris	!	!	!
Ranunculus harveyi	!	!	!
Ranunculus hispidus var. caricetorum	R. septentrionalis var. caricetorum	!	!
Ranunculus hispidus var. hispidus	R. hispidus incl. var. marilandicus	!	!
Ranunculus hispidus var. nitidus	R. septentrionalis incl. var. pterocarpus	!	!
Ranunculus laxicaulis	!	!	!
Ranunculus micranthus	! incl. var. delitescens	!	!
RANUNCULUS PARVIFLORUS	!	!	!
Ranunculus pusillus	!	!	!
Ranunculus recurvatus	!	!	!
RANUNCULUS REPENS	! incl. var. pleniflorus	!	!
RANUNCULUS SARDOUS	!	!	!
Ranunculus sceleratus	!	!	!
RAPHANUS RAPHANISTRUM	!	!	!
RAPHANUS SATIVUS	!	!	!
RAPISTRUM RUGOSUM	not included	!	!
RATIBIDA COLUMNIFERA	!	!	!
Ratibida pinnata	!	!	!
RATIBIDA TAGETES	!	!	!
RESEDA LUTEA	not included	!	!
RESEDA LUTEOLA	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Rhamnus caroliniana	! incl. var. mollis	!	Frangula caroliniana
RHAMNUS CATHARTICA	! in part	!	!
RHAMNUS DAVURICA	not included	!	!
RHAMNUS JAPONICA	R. cathartica in part	!	!
Rhamnus lanceolata	! incl. var. glabrata	!	! incl. subsp. glabra
Rhexia mariana var. interior	R. interior	!	!
Rhexia mariana var. mariana	!	!	!
Rhexia virginica	!	!	!
Rhododendron prinophyllum	R. roseum	!	!
RHODOTYPOS SCANDENS	not included	!	!
Rhus aromatica var. aromatica	! incl. var. illinoensis	!	!
Rhus aromatica var. serotina	!	!	!
Rhus copallinum var. latifolia	R. copallina var. latifolia	!	as var. latifolia
Rhus glabra	!	!	!
RHUS TYPHINA	!	!	!
Rhynchosia difformis	!	!	!
Rhynchosia latifolia	!	!	!
Rhynchospora capillacea	!	!	!
Rhynchospora capitellata	!	!	!
Rhynchospora corniculata	!	!	!
Rhynchospora globularis var. recognita	!	!	R. recognita
Rhynchospora harveyi	!	!	!
Rhynchospora macrostachya	!	!	!
Rhynchospora scirpoides	not included	not included	!
Ribes americanum	not included	!	!
Ribes cynosbati	!	!	!
Ribes missouriense	! incl. var. ozarkanum	!	!
Ribes odoratum	!	!	R. aureum var. villosum
RICINUS COMMUNIS	!	!	!
ROBINIA HISPIDA	!	!	!
ROBINIA PSEUDOACACIA	R. "pseudo-acacia"	!	!
Robinia pseudoacacia	R. "pseudo-acacia"	!	!
Rorippa aquatica	Armoracia aquatica	!	Neobeckia aquatica
Rorippa curvipes	R. obtusa in part	!	! incl. var. truncata
Rorippa palustris var. fernaldiana	R. islandica incl. vars. fernaldiana & hispida	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Rorippa sessiliflora	!	!	!
Rorippa sinuata	!	!	!
RORIPPA SYLVESTRIS	!	!	!
Rorippa tenerrima	R. obtusa in part	!	!
Rosa arkansana	as var. suffulta	!	as var. suffulta
Rosa blanda	!	!	!
ROSA CANINA	! incl. var. dumetorum	!	!
Rosa carolina subsp. carolina	! incl. vars. grandiflora & villosa	!	R. carolina in part
Rosa carolina subsp. subserrulata	R. virginiana	!	R. carolina in part
ROSA GALLICA	! incl. var. officinalis	!	!
ROSA LUCIEAE	not included	!	R. wichuriana
ROSA MULTIFLORA	!	!	!
Rosa palustris	!	!	!
ROSA RUBIGINOSA	R. eglanteria, R. micrantha	! incl. R. micrantha	! incl. R. micrantha
ROSA RUGOSA	!	!	!
Rosa setigera	! incl. var. tomentosa	!	! incl. var. tomentosa
ROSA SPINOSISSIMA	!	!	!
ROSA WOODSII	(!)	!	!
Rotala ramosior	! incl. var. interior	!	!
Rubus ablatus	R. ostryifolius in part	!	R. laudatus in part
Rubus aboriginum	R. enslenii in part	!	!
Rubus allegheniensis	! incl. var. plausus	!	!
Rubus alumnus	R. orarius	!	!
Rubus argutus	!	!	!
RUBUS ARMENIACUS	R. bifrons & R. procerus	!	! incl. R. bifrons
Rubus celer	R. enslenii in part	!	R. fecundus
Rubus curtipes	R. flagellaris in part	!	!
Rubus deamii	R. invisus	!	!
Rubus enslenii	! in part	!	R. flagellaris in part
Rubus flagellaris	! in part, incl. var. occidualis	!	! in part
Rubus frondosus	R. pensilvanicus in part	!	!
RUBUS IDAEUS var. STRIGOSUS	!	!	!
RUBUS LACINIATUS	!	!	!
Rubus laudatus	R. pensilvanicus in part	!	! in part
Rubus leviculus	R. enslenii in part	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Rubus meracus	R. flagellaris in part	!	!
Rubus missouricus	!	!	!
Rubus mollior	!	!	!
Rubus occidentalis	!	!	!
RUBUS PARVIFOLIUS	not included	!	not included
RUBUS PHOENICOLASIUS	not included	!	!
Rubus plicatifolius	not included	(!)	!
Rubus roribaccus	R. flagellaris in part	!	!
Rubus rosa	R. pensilvanicus in part	!	!
Rubus satis	R. flagellaris in part	!	R. ithacanus
RUBUS SERISSIMUS	not included	!	R. pascuus
Rubus steelei	R. flagellaris in part	!	!
Rubus trivialis	!	!	!
Rudbeckia amplexicaulis	Dracopis amplexicaulis	!	Dracopis amplexicaulis
Rudbeckia bicolor	R. hirta in part	R. hirta in part	R. hirta in part
Rudbeckia fulgida var. sullivantii	as var. speciosa	!	as var. speciosa
Rudbeckia fulgida var. umbrosa	!	!	! incl. var. palustris
RUDBECKIA GRANDIFLORA	!	!	!
Rudbeckia hirta	! in part	as var. pulcherrima in part	as var. pulcherrima in part
Rudbeckia laciniata	!	!	!
RUDBECKIA MAXIMA	!	!	!
Rudbeckia missouriensis	!	!	!
Rudbeckia subtomentosa	!	!	!
Rudbeckia triloba	!	!	!
Ruellia humilis	! incl. vars. longiflora & expansa	!	!
Ruellia pedunculata	!	!	!
Ruellia strepens	!	!	!
RUMEX ACETOSELLA	!	!	!
Rumex altissimus	!	!	!
RUMEX CONGLOMERATUS	!	!	!
RUMEX CRISPUS	!	!	!
RUMEX CRISTATUS	R. orbiculatus	!	!
RUMEX DENTATUS	not included	!	!
Rumex fueginus	R. maritimus var. fueginus	!	R. maritimus var. fueginus
Rumex hastatulus	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
RUMEX OBTUSIFOLIUS	!	!	!
RUMEX PATIENTIA	!	!	!
RUMEX PULCHER	!	!	!
RUMEX STENOPHYLLUS	!	!	!
Rumex triangulivalvis	R. mexicanus	!	R. salicifolius var. mexicanus
Rumex verticillatus	!	!	!
Ruppia maritima	as var. rostrata	!	R. cirrhosa
RUTA GRAVEOLENS	!	!	!
Sabatia angularis	!	!	!
Sabatia brachiata	!	!	!
Sabatia campestris	!	!	!
Sacciolepis striata	not included	!	!
Sagina decumbens	!	!	!
SAGINA PROCUMBENS	not included	!	!
Sagittaria ambigua	!	!	!
Sagittaria brevirostra	S. engelmanniana subsp. brevirostra	!	!
Sagittaria calycina	S. montevedienses subsp. calycina	!	!
Sagittaria graminea	as var. graminea	!	!
Sagittaria latifolia	!	!	!
Sagittaria platyphylla	S. graminea var. platyphylla	!	!
Sagittaria rigida	!	!	!
SALICORNIA EUROPAEA	not included	!	S. depressa
SALIX × FRAGILIS	S. fragilis	!	S. fragilis
SALIX × SEPULCRALIS	S. babylonica	!	!
SALIX ALBA	! incl. vars. calva & vitellina	!	!
Salix amygdaloides	!	!	!
Salix caroliniana	!	!	!
Salix discolor	!	!	!
Salix eriocephala	! in part, incl. var. angustata	!	!
Salix famelica	S. rigida in part	!	S. lutea
Salix humilis	! incl. vars. hyoprhysa & microphylla	! incl. var. tristis	! incl. var. tristis
Salix interior	!	!	!
Salix nigra	!	!	!
Salix petiolaris	S. gracilis var. textoris	!	!
SALIX PURPUREA	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Salix sericea	!	!	!
SALSOLA COLLINA	not included	!	!
SALSOLA TRAGUS	S. kali incl. var. tenuifolia	!	!
Salvia azurea var. grandiflora	!	!	!
SALVIA COCCINEA	not included	!	!
Salvia lyrata	!	!	!
Salvia reflexa	!	!	!
Sambucus canadensis	! incl. var. submollis	!	S. nigra subsp. canadensis
Sambucus pubens	!	!	S. racemosa
Samolus parviflorus	!	!	S. valerandi subsp. parviflorus
Sanguinaria canadensis	! incl. var. rotundifolia	!	!
Sanicula canadensis	! incl. var. grandis	!	! incl. var. grandis
Sanicula odorata	S. gregaria	!	!
Sanicula smallii	!	!	!
Sapindus saponaria var. drummondii	S. drummondii	!	!
SAPONARIA OFFICINALIS	!	!	!
Sassafras albidum	! incl. var. molle	!	!
Saururus cernuus	!	!	!
SCABIOSA ATROPURPUREA	not included	!	!
Schedonnardus paniculatus	!	!	!
Schizachyrium scoparium	Andropogon scoparius	!	!
Schoenoplectus acutus	Scirpus acutus	!	!
Schoenoplectus americanus	Scirpus olneyi	!	!
SCHOENOPLECTUS CALIFORNICUS	not included	not included	!
Schoenoplectus deltarum	not included	!	!
Schoenoplectus etuberculatus	Scirpus etuberculatus	!	!
Schoenoplectus hallii	Scirpus hallii	!	!
Schoenoplectus heterochaetus	Scirpus heterochaetus	!	!
SCHOENOPLECTUS MUCRONATUS	not included	!	!
Schoenoplectus pungens	Scirpus americanus	! incl. var. longispicatus	! incl. var. longispicatus
SCHOENOPLECTUS PURSHIANUS	not included	!	!
Schoenoplectus saximontanus	not included	!	!
Schoenoplectus subterminalis	Scirpus subterminalis	!	!
Schoenoplectus tabernaemontani	Scirpus validus var. creber	!	!
Schoenoplectus torreyi	Scirpus torreyi	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
SCILLA SIBERICA	!	!	!
Scirpus atrovirens	as var. atrovirens	!	!
Scirpus cyperinus	! incl. var. pelius	! in part	! in part
Scirpus divaricatus	!	!	!
Scirpus georgianus	S. atrovirens var. georgianus	!	!
Scirpus pallidus	S. atrovirens var. pallidus	!	!
Scirpus pedicellatus	not included	!	!
Scirpus pendulus	S. lineatus	!	!
Scirpus polyphyllus	!	!	!
Scirpus rubricosus	!	S. cyperinus in part	S. cyperinus in part
SCLERANTHUS ANNUUS	!	!	!
Scleria ciliata	! incl. var. elliottii	!	!
Scleria oligantha	!	!	!
Scleria pauciflora	! incl. var. caroliniana	!	! incl. var. caroliniana
Scleria reticularis var. pubescens	S. muhlenbergii	!	S. muehlengergii & S. reticularis
Scleria triglomerata	! incl. S. nitida	!	!
Scleria verticillata	!	!	!
SCLEROCHLOA DURA	not included	!	!
Scrophularia lanceolata	!	!	!
Scrophularia marilandica	!	!	!
Scutellaria bushii	!	!	!
Scutellaria elliptica	! incl. var. hirsuta & S. serrata	! incl. var. hirsuta	! incl. var. hirsuta
Scutellaria galericulata	S. epilobiifolia	!	!
Scutellaria incana	! incl. var. punctata	!	! incl. var. punctata & S. integrifolia
Scutellaria lateriflora	!	!	!
Scutellaria nervosa	! incl. var. calvifolia	!	!
Scutellaria ovata	! incl. vars. rugosa & versicolor	! incl. vars. bracteata & rugosa	! incl. subsp. bracteata
Scutellaria parvula var. australis	!	!	!
Scutellaria parvula var. missouriensis	S. parvula var. leonardii	!	!
Scutellaria parvula var. parvula	!	!	!
SECALE CEREALE	!	!	!
SECURIGERA VARIA	Coronilla varia	!	!
SEDUM ACRE	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
SEDUM ERYTHROSTICTUM	S. telephium in part	!	Hylotelephium erythrostictum
Sedum nuttallianum	!	!	!
Sedum pulchellum	!	!	!
SEDUM PURPUREUM	S. telephium in part	!	Hylotelephium telephium subsp. telephium
SEDUM REFLEXUM	not included	!	!
SEDUM SARMENTOSUM	!	!	!
Sedum ternatum	!	!	!
Selaginella apoda	in part	!	!
Selaginella eclipes	S. apoda in part	!	!
Selaginella rupestris	!	!	!
Selenia aurea	!	!	!
SENECIO AMPULLACEUS	!	!	!
SENECIO VULGARIS	!	!	!
Senna marilandica	Cassia marilandica	!	!
Senna obtusifolia	Cassia tora	!	!
SENNA OCCIDENTALIS	Cassia occidentalis	!	!
SESAMUM INDICUM	!	!	S. orientale
Sesbania herbacea	S. exaltata	!	!
SESBANIA VESICARIA	not included	!	!
SETARIA FABERI	S. "faberii"	!	!
SETARIA GLAUCA	!	!	S. pumila subsp. pumila
SETARIA ITALICA	!	!	!
Setaria parviflora	S. geniculata	!	!
SETARIA VERTICILLATA	! incl. var. ambigua	! incl. var. ambigua	!
SETARIA VIRIDIS var. MAJOR	not included	!	!
SETARIA VIRIDIS var. VIRIDIS	!	!	!
SHERARDIA ARVENSIS	!	!	!
Sicyos angulatus	!	!	!
Sida elliottii	!	!	!
SIDA SPINOSA	!	!	!
Sideroxylon lanuginosum subsp. oblongifolium	Bumelia lanuginosa var. albicans	!	!
Sideroxylon lycioides	Bumelia lycioides	!	as subsp. longifolium
Silene antirrhina	!	!	!
Silene caroliniana var. wherryi	!	!	as subsp. wherryi

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
SILENE CONOIDEA	!	!	!
SILENE CSEREII	S. "cserei"	!	!
SILENE DICHOTOMA	!	!	!
SILENE DIOICA	Lychnis dioica	!	!
SILENE GALLICA	!	!	!
SILENE LATIFOLIA	Lychnis alba	!	as subsp. alba
Silene nivea	!	!	!
SILENE NOCTIFLORA	!	!	!
Silene regia	!	!	!
Silene stellata	!	!	!
Silene virginica	!	!	!
SILENE VULGARIS	S. cucubalus	!	!
Silphium asteriscus	!	!	!
Silphium integrifolium var. integrifolium	!	!	! incl. var. deamii
Silphium integrifolium var. laeve	!	!	!
Silphium laciniatum	!	!	!
Silphium perfoliatum	!	!	!
SILPHIUM RADULA	not included	!	!
Silphium terebinthinaceum	!	!	!
SILYBUM MARIANUM	not included	!	!
SINAPIS ALBA	Brassica hirta	!	!
SINAPIS ARVENSIS	Brassica kaber var. pinnatifida	!	!
SISYMBRIUM ALTISSIMUM	!	!	!
SISYMBRIUM LOESELII	!	!	!
SISYMBRIUM OFFICINALE	! incl. var. leiocarpum	!	!
Sisyrinchium albidum	!	!	!
Sisyrinchium angustifolium	S. bermudiana	!	!
Sisyrinchium atlanticum	!	!	!
Sisyrinchium campestre	!	!	!
Sium suave	!	!	!
Smallanthus uvedalius	Polymnia uvedalia incl. var. densipilis	!	!
Smilax bona-nox	! incl. var. hederaefolia	!	!
Smilax ecirrhata	!	!	!
Smilax glauca	! incl. var. leurophylla	!	!
Smilax hispida	S. tamnoides var. hispida	!	S. tamnoides
Smilax illinoensis	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Smilax lasioneuron	S. herbacea incl. var. lasioneura	!	S. "lasioneura", incl. S. herbacea
Smilax pulverulenta	!	!	!
Smilax rotundifolia	!	!	!
Solanum americanum	!	!	!
Solanum carolinense	!	!	!
SOLANUM DIMIDIATUM	S. torreyi	!	!
SOLANUM DULCAMARA	!	!	!
Solanum elaeagnifolium	!	!	!
SOLANUM LYCOPERSICUM	Lycopersicon esculentum	!	!
SOLANUM NIGRUM	(!)	!	!
SOLANUM PSEUDOCAPSICUM	not included	!	!
Solanum ptycanthum	S. americanum & S. villosum	!	!
SOLANUM ROSTRATUM	!	!	!
SOLANUM SARACHOIDES	!	!	S. physalifolium
SOLANUM TRIFLORUM	!	!	!
SOLANUM TUBEROSUM	!	!	!
Solidago altissima var. altissima	!	!	!
Solidago altissima var. gilvicanescens	S. canadensis gilvocanescens in part	!	S. canadensis var. gilvocanescens
Solidago arguta	! incl. vars. boottii, neurolepis & strogisa	! incl. vars. boottii & caroliniana	! incl. vars. boottii, caroliniana & neurolepis
Solidago buckleyi	!	!	!
Solidago caesia	!	!	!
Solidago canadensis var. hargeri	as var. gilvocanescens in part	!	!
Solidago drummondii	!	!	S. rugosa subsp. aspera
Solidago flexicaulis	!	!	!
Solidago gattingeri	!	!	!
Solidago gigantea	! incl. var. leiophylla	!	!
Solidago hispida	!	!	S. bicolor in part
Solidago juncea	!	!	!
Solidago missouriensis subsp. fasciculata	! incl. var. missouriensis	!	as var. fasciculata
Solidago nemoralis var. longipetiolata	as var. decemiflora	as subsp. decemiflora	!
Solidago nemoralis var. nemoralis	!	as subsp. nemoralis	!
Solidago odora	!	!	!
Solidago patula	!	!	! incl. var. strictula

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Solidago petiolaris	! incl. var. wardii	!	as var. angusta
Solidago radula	! incl. vars. laeta & stenolepis	!	! incl. vars. laeta & stenolepis
Solidago rugosa	! incl. vars. aspera & celtidifolia	! incl. subsp. aspera	as subsp. rugosa
Solidago speciosa var. rigidiuscula	!	!	!
Solidago speciosa var. speciosa	!	!	!
Solidago ulmifolia	! incl. var. palmeri	! incl. var. palmeri	! incl. var. palmeri
SONCHUS ARVENSIS subsp. ARVENSIS	S. arvensis var. arvensis	!	!
SONCHUS ARVENSIS subsp. ULIGINOSUS	S. arvensis var. glabrescens	!	!
SONCHUS ASPER	!	!	!
SONCHUS OLERACEUS	!	!	!
Sorghastrum nutans	!	!	!
SORGHUM BICOLOR	S. cafforum, S. caudatum, S. dochna incl. var. technicum, S. drummondii, S. dura & S. sudanense	! incl. subsp. drummondii	! incl. subsp. drummondii
SORGHUM HALEPENSE	!	!	!
Sparganium americanum	!	!	!
Sparganium androcladum	!	!	!
Sparganium eurycarpum	!	!	!
Spartina pectinata	!	!	!
SPERGULA ARVENSIS	!	!	!
SPERGULARIA SALINA	not included	!	!
Spermacoce glabra	!	!	!
Spermolepis divaricata	!	!	!
Spermolepis echinata	!	!	!
Spermolepis inermis	!	!	!
SPHAERALCEA FENDLERI	not included	!	!
SPHENOCLEA ZEYLANDICA	not included	!	!
Sphenopholis nitida	!	!	!
Sphenopholis obtusata var. major	S. intermedia	!	S. intermedia
Sphenopholis obtusata var. obtusata	! incl. var. lobata	!	S. obtusata
Sphenopholis pensylvanica	Trisetum pensylvanicum	!	!
Spigelia marilandica	!	!	!
SPIRAEA × VANHOUTTEI	not included	!	!
Spiraea alba	!	!	!
SPIRAEA DOUGLASII	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
SPIRAEA JAPONICA	not included	!	!
SPIRAEA PRUNIFOLIA	as var. plena	!	!
Spiraea tomentosa	!	!	!
Spiranthes cernua	as var. cernua	!	!
Spiranthes lacera	S. gracilis	!	!
Spiranthes lucida	!	!	!
Spiranthes magnicamporum	S. cernua var. ochroleuca	!	!
Spiranthes ovalis var. erostellata	S. ovalis	!	!
Spiranthes tuberosa	!	!	!
Spiranthes vernalis	!	!	!
Spirodela polyrhiza	!	!	!
SPIRODELA PUNCTATA	S. oligorhiza	!	Landoltia punctata
SPOROBOLUS AIROIDES	!	!	!
Sporobolus clandestinus	! incl. var. canovirens	!	!
Sporobolus compositus var. compositrus	S. asper incl. var. pilosus, in part	!	!
Sporobolus compositus var. drummondii	S. asper var. hookeri	!	!
Sporobolus compositus var. macer	S. asper incl. var. hookeri, in part	!	!
Sporobolus cryptandrus	!	!	!
Sporobolus heterolepis	!	!	!
SPOROBOLUS INDICUS	S. poiretii	!	!
Sporobolus neglectus	as var. neglectus	!	!
Sporobolus ozarkanus	S. neglectus var. ozarkanus	!	S. vaginiflorus var. ozarkanus
SPOROBOLUS PYRAMIDATUS	!	!	!
Sporobolus vaginiflorus	! incl. var. inaequalis	!	as var. vaginiflorus
Stachys aspera	S. hyssopifolia var. ambigua	!	!
Stachys hispida	S. tenuifolia var. hispida	!	S. tenuifolia in part
Stachys pilosa	S. palustris incl. vars. nippogensis & phaneropoda	!	! incl. var. arenicola
Stachys tenuifolia	as var. tenuifolia	!	in part
Staphylea trifolia	!	!	!
Steinchisma hians	Panicum hians	Panicum hians	!
STELLARIA GRAMINEA	!	!	!
Stellaria longifolia	!	!	!
STELLARIA MEADIA	!	!	as subsp. meadia

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
STELLARIA NEGLECTA	not included	!	S. meadia subsp. neglecta
STELLARIA PALLIDA	not included	!	S. meadia subsp. pallida
Stenanthium gramineum	!	!	!
Stenosiphon linifolius	!	Oenothera glaucifolia	!
STENOTAPHRUM SECUNDATUM	not included	!	!
Stipa spartea	!	!	Hesperostipa spartea
Strophostyles helvola var. helvola	!	S. helvola in part	S. helvola in part
Strophostyles helvola var. missouriensis	!	S. helvola in part	S. helvola in part
Strophostyles leiosperma	!	!	!
Strophostyles umbellata	!	!	!
Stylisma pickeringii var. pattersonii	not included	!	!
Stylophorum diphyllum	!	!	!
Stylosanthes biflora	!	!	!
Styrax americanus	S. "americana"	!	!
Styrax grandifolius	not included	!	!
SUAEDA CALCEOLIFORMIS	S. depressa	!	!
Sullivantia sullivantii	S. renifolia	!	!
SYMPHORICARPOS ALBUS	(as var. laevigatus)	!	as var. laevigatus
Symphoricarpos occidentalis	!	!	!
Symphoricarpos orbiculatus	!	!	!
Symphyotrichum × amethystinum	Aster × amethystinus	!	!
Symphyotrichum anomalum	Aster anomalus	!	!
SYMPHYOTRICHUM CILIATUM	Aster brachyactis	!	!
Symphyotrichum cordifolium	Aster cordifolius incl. vars. moratus & polycephalus	!	!
Symphyotrichum drummondii	Aster drummondii	!	! incl. var. texanum
Symphyotrichum dumosum var. strictior	Aster dumosus vars. dodgei & strictior	!	!
Symphyotrichum ericoides	Aster ericoides	! incl. var. prostratum	!
SYMPHYOTRICHUM FALCATUM subsp. COMMUTATUM	Aster commutatus	!	as var. commutatum
Symphyotrichum laeve	Aster laevis	!	! incl. var. geyeri
Symphyotrichum lanceolatum var. interior	Aster simplex var. interior	!	!
Symphyotrichum lanceolatum var. lanceolatum	A. simplex incl. var. ramosissimum	! incl. var. latifolium	! incl. var. latifolium
Symphyotrichum lateriflorum	Aster lateriflorus	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Symphyotrichum novae-angliae	Aster novae-angliae	!	!
Symphyotrichum oblongifolium	Aster oblongifolius incl. var. angustatus	!	!
Symphyotrichum ontarionis	Aster ontarionis	!	!
Symphyotrichum oolentangiense	Aster azureus, incl. var. poaceus	! incl. var. poaceum	! incl. var. poaceum
Symphyotrichum parviceps	Aster parviceps	!	!
Symphyotrichum patens	Aster patens incl. var. patentissimus	! incl. vars. gracile & patentissimum	! incl. vars. gracile & patentissimum
Symphyotrichum pilosum var. pilosum	Aster pilosus incl. var. platyphyllus	S. pilosum in part	!
Symphyotrichum pilosum var. pringlei	Aster pilosus var. demotus	S. pilosum in pat	!
Symphyotrichum praealtum	Aster praealtus incl. vars. angustior & subasper	!	! incl. var. subasperum
Symphyotrichum puniceum	Aster puniceus var. firmus	!	!
Symphyotrichum racemosum var. subdumosum	Aster vimineus incl. var. subdumosus	!	S. racemosum
Symphyotrichum sericeum	Aster sericeus	!	!
SYMPHYOTRICHUM SUBULATUM var. LIGULATUM	Aster exilis	!	S. divaricatum
Symphyotrichum turbinellum	Aster turbinellus	!	!
Symphyotrichum urophyllum	Aster sagittifolius	!	!
SYMPHYTUM OFFICINALE	!	!	!
SYRINGA VULGARIS	!	!	!
Taenidia integerrima	!	!	!
TAGETES ERECTA	!	!	!
TAGETES PATULA	not included	!	!
TALINUM PANICULATUM	not included	!	!
TAMARIX RAMOSISSIMA	T. gallica	!	!
TANACETUM BALSAMITA	Chrysanthemum balsamita var. tanacetoides	!	!
TANACETUM PARTHENIUM	Chrysanthemum parthenium	!	!
TANACETUM VULGARE	!	!	!
TARAXACUM ERYTHROSPERMUM	!	!	T. laevigatum
TARAXACUM OFFICINALE	!	!	!
Taxodium distichum	!	!	!
Tephrosia virginiana	! incl. var. holosericea	!	!
TETRADIUM DANIELII	not included	!	not included
Teucrium canadense var. canadense	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Teucrium canadense var. occidentale	!	!	!
Thalia dealbata	!	!	!
Thalictrum dasycarpum	! incl. var. hypoglaucum	!	!
Thalictrum dioicum	!	!	!
Thalictrum revolutum	!	!	!
Thalictrum thalictroides	Anemonella thalictroides	!	!
Thaspium barbinode	!	!	!
Thaspium trifoliatum var. flavum	!	!	as var. aureum
Thaspium trifoliatum var. trifoliatum	!	!	!
Thelesperma filifolium	T. ambiguum & T. trifidum	!	as var. intermedium
THELESPERMA MEGAPOTAMICUM	!	!	!
Thelypteris palustris var. pubescens	!	!	!
THLASPI ALLIACEUM	not included	!	!
THLASPI ARVENSE	!	!	!
TIDESTROMIA LANUGINOSA	!	!	!
Tilia americana var. americana	! incl. var. neglecta	!	!
Tilia americana var. heterophylla	T. heterophylla	!	! incl. var. caroliniana
Tipularia discolor	not included	!	!
TIQUILIA NUTTALLII	Coldenia nuttallii	!	!
TORILIS ARVENSIS	T. japonica	!	!
TORILIS JAPONICA	(reports are based on T. arvensis)	!	!
TORILIS NODOSA	!	!	!
Torreyochloa pallida	Glyceria pallida	!	!
Toxicodendron pubescens	Rhus toxicodendron	!	!
Toxicodendron radicans	Rhus radicans incl. var. vulgaris	! incl. subspp. negundo & pubens	! incl. subspp. negundo, pubens & verrucosum
Trachelospermum difforme	!	!	!
Tradescantia bracteata	!	!	!
Tradescantia ernestiana	!	!	!
Tradescantia longipes	!	!	!
Tradescantia ohiensis	!	!	!
Tradescantia ozarkana	!	!	!
Tradescantia subaspera	!	!	!
Tradescantia tharpii	!	!	!
Tradescantia virginiana	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Tragia betonicifolia	T. urticifolia in part	!	!
Tragia cordata	!	!	!
Tragia ramosa	T. urticifolia in part	!	!
TRAGOPOGON DUBIUS	!	!	!
TRAGOPOGON PORRIFOLIUS	!	!	!
TRAGOPOGON PRATENSIS	!	!	T. lamottei
Trautvettaria caroliniensis	!	!	!
Trepocarpus aethusae	not included	!	!
Triadenum tubulosum	Hypericum tubulosum	!	!
Triadenum walteri	Hypericum walteri	!	!
TRIANTHEMA PORTULACASTRUM	!	!	!
TRIBULUS TERRESTRIS	!	!	!
Trichophorum planifolium	Scirpus verrecundus	!	!
Trichostema brachiatum	Isanthus brachiatus	!	!
Trichostema dichotomum	! incl. var. puberulum	!	!
Trichostema setaceum	!	!	!
Tridens flavus var. chapmanii	T. chapmani	!	!
Tridens flavus var. flavus	T. flavus	!	!
Tridens muticus var. elongatus	T. elongatus	!	in part
Tridens strictus	!	!	!
TRIFOLIUM ARVENSE	!	!	!
TRIFOLIUM AUREUM	T. agrarium	!	!
TRIFOLIUM CAMPESTRE	!	!	!
Trifolium carolinianum	!	!	!
TRIFOLIUM DUBIUM	!	!	!
TRIFOLIUM HYBRIDUM	as var. pratense	!	!
TRIFOLIUM INCARNATUM	!	!	!
TRIFOLIUM PRATENSE	! incl. var. sativum	!	!
Trifolium reflexum	! incl. var. glabrum	!	!
TRIFOLIUM REPENS	!	!	!
TRIFOLIUM RESUPINATUM	!	!	!
Trifolium stoloniferum	!	!	!
TRIFOLIUM STRIATUM	not included	!	!
TRIFOLIUM VESCICULOSUM	not included	!	!
Trillium flexipes	!	!	!
Trillium nivale	!	!	!
Trillium pusillum var. ozarkanum	!	!	!
Trillium recurvatum	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Trillium sessile	!	!	!
Trillium viride	in part	!	!
Trillium viridescens	T. viride in part	!	!
Triodanis biflora	Specularia biflora	!	!
Triodanis holzingeri	Specularia holzingeri	!	!
Triodanis lamprosperma	Specularia lamprosperma	!	!
Triodanis leptocarpa	Specularia leptocarpa	!	!
Triodanis perfoliata	Specularia perfoliata	!	!
Triosteum angustifolium	! incl. var. eamsii	!	!
Triosteum aurantiacum	as var. illinoense	as var. illinoense	! incl. var. illinoense
Triosteum perfoliatum	!	!	!
Triphora trianthophora	!	!	!
Triplasis purpurea	!	!	!
TRIPLEUROSPERMUM INODORUM	Matricaria maritima var. agrestis	!	T. perforatum
Tripsacum dactyloides	!	!	!
TRISETUM FLAVESCENS	!	!	!
TRITICUM AESTIVUM	!	!	!
TSUGA CANADENIS	not included	!	!
Turritis glabra	Arabis glabra	!	Arabis glabra
Typha × glauca	!	!	!
Typha angustifolia	!	!	!
Typha domingensis	not included	!	!
Typha latifolia	!	!	!
ULMUS × INTERMEDIA	not included	!	U. × notha
Ulmus alata	!	!	!
Ulmus americana	!	!	!
Ulmus crassifolia	not included	!	!
ULMUS MINOR	not included	!	U. procera
ULMUS PUMILA	!	!	!
Ulmus rubra	!	!	!
Ulmus thomasi	!	!	!
UROCHLOA PLATYPHYLLA	Brachiaria platyphylla	!	!
UROCHLOA RAMOSA	not included	not included	!
UROCHLOA TEXANA	Panicum texanum	!	!
Urtica chamaedryoides	!	!	!
URTICA DIOICA subsp. DIOICA	not included	!	!
Urtica dioica subsp. gracilis	U. dioica var. procera	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
URTICA URENS	!	!	!
Utricularia gibba	!	!	!
Utricularia minor	not included	!	!
Utricularia subulata	not included	!	!
Utricularia vulgaris subsp. macrorhiza	U. vulgaris	!	U. macrorhiza
Uvularia grandiflora	!	!	!
Uvularia sessilifolia	!	!	!
VACCARIA HISPANICA	Saponaria vaccaria	!	!
Vaccinium arboreum	! incl. var. glaucescens	!	!
VACCINIUM CORYMBOSUM	not included	!	!
Vaccinium pallidum	V. vacillans incl. vars. crinitum & missouriense	!	!
Vaccinium stamineum	as vars. interius, melanocarpum & neglectum	!	!
VALERIANELLA LOCUSTA	V. olitoria	!	!
Valerianella ozarkana	! incl. V. bushii	!	!
Valerianella radiata	! incl. vars. fernaldii & missouriensis; V. stenocarpa var. parviflora	!	!
Vallisneria americana	!	!	!
Veratrum woodii	!	!	!
VERBASCUM BLATTARIA	!	!	!
VERBASCUM LYCHNITIS	not included	!	!
VERBASCUM PHLOMOIDES	not included	!	!
VERBASCUM THAPSUS	!	!	!
VERBENA BONARIENSIS	not included	!	!
Verbena bracteata	!	!	!
VERBENA BRASILIENSIS	not included	!	!
Verbena hastata	!	!	!
Verbena simplex	!	!	!
Verbena stricta	!	!	!
Verbena urticifolia	!	!	!
Verbesina alternifolia	!	!	!
VERBESINA ENCELIOIDES	as var. exauriculata	!	! incl. subsp. exauriculata
Verbesina helianthoides	!	!	!
Verbesina virginica	!	!	!
Vernonia arkansana	V. crinita	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Vernonia baldwinii	V. "baldwini" incl. var. interior	! incl. subsp. interior	! incl. subsp. interior
Vernonia fasciculata	!	!	!
Vernonia gigantea	V. altissima	!	!
Vernonia missurica	!	!	!
Veronica americana	!	!	!
VERONICA ANAGALLIS-AQUATICA	not included	!	in part
VERONICA ARVENSIS	!	!	!
VERONICA BECCABUNGA	not included	!	!
Veronica catenata	V. comosa	!	V. anagallis-aquatica in part
VERONICA CHAMAEDRYS	not included	!	!
VERONICA HEDERIFOLIA	not included	!	!
VERONICA LONGIFOLIA	!	!	Pseudolysimachion longifolium
Veronica peregrina	! incl. var. xalapensis	!	! incl. var. xalapensis
VERONICA PERSICA	not included	!	!
VERONICA POLITA	!	!	!
VERONICA SCHEEREI	not included	!	not included
VERONICA SERPYLLIFOLIA	!	!	!
VERONICA TEUCRIUM	not included	!	V. austriaca subsp. teucrium
VERONICA TRIPHYLLOS	not included	!	!
Veronicastrum virginicum	!	!	!
Viburnum bracteatum	not included	!	V. molle in part
Viburnum dentatum	as var. deamii	!	!
VIBURNUM LANTANA	not included	!	!
Viburnum lentago	!	!	!
Viburnum molle	!	!	in part
VIBURNUM OPULUS var. OPULUS	not included	!	!
Viburnum prunifolium	!	!	!
Viburnum rafinesquianum	! incl. var. affine	!	!
Viburnum recognitum	!	!	!
Viburnum rufidulum	!	!	!
Vicia americana	! incl. var. truncata	!	!
Vicia caroliniana	!	!	!
VICIA CRACCA	(!)	!	!
VICIA GRANDIFLORA	!	!	!
VICIA HIRSUTA	!	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Vicia ludoviciana	!	as subsp. leavenworthii	! incl. subsp. leavenworthii
Vicia minutiflora	!	!	!
VICIA SATIVA subsp. NIGRA	as V. sativa vars. nigra & segatlis	!	!
VICIA VILLOSA subsp. VARIA	V. dasycarpa	!	!
VICIA VILLOSA subsp. VILLOSA	V. villosa	!	!
VIGNA UNGUICULATA	V. sinensis	!	!
VINCA MAJOR	not included	!	!
VINCA MINOR	!	!	!
Viola affinis	(!)	!	!
VIOLA ARVENSIS	(!)	!	!
Viola bicolor	V. kitaibeliana var. rafinesquii	!	!
Viola cucullata	!	!	!
Viola lanceolata	!	!	!
Viola missouriensis	!	!	!
Viola nephrophylla	V. papilionacea in part	!	!
Viola pallens	!	!	Viola macloskeyi subsp. pallens
Viola palmata	V. triloba	!	V. triloba incl. var. dilatata
Viola pedata	! incl. var. linariloba	!	!
Viola pedatifida	!	!	!
Viola pubescens	V. pensylvanica incl. var. leiocarpa	!	! incl. var. scabriuscula
Viola sagittata	!	!	!
Viola sororia	!	!	! incl. V. affinis
Viola striata	!	!	!
VIOLA TRICOLOR	!	!	!
Viola viarum	!	!	V. × viarum
VITEX NEGUNDO	not included	!	!
Vitis aestivalis	! incl. var. argentifolia	!	!
Vitis cinerea	!	!	!
VITIS LABRUSCANA	!	!	V. labrusca
Vitis palmata	!	!	!
Vitis riparia	! incl. vars. praecox & syrticola	!	!
Vitis rotundifolia	!	!	!
Vitis rupestris	!	!	!
Vitis vulpina	!	!	!
VULPIA BROMOIDES	not included	!	!

Table 2

SCIENTIFIC NAME	Steyermark	Yatskievych	USDA
Vulpia elliotea	Festuca sciurea	!	!
VULPIA MYUROS	Festuca myuros	!	!
Vulpia octoflora var. glauca	! incl. var. tenella	!	!
Vulpia octoflora var. octoflora	!	!	!
Wisteria frutescens	as var. macrostachya	!	!
WISTERIA SINENSIS	not included	!	!
Wolffia borealis	W. punctata	!	!
Wolffia braseliensis	W. papulifera	!	!
Wolffia columbiana	!	!	!
Wolffiella gladiata	W. floridana	!	!
Woodsia obtusa	!	! incl. subsp. occidentalis	!
Woodwardia areolata	!	!	!
XANTHIUM SPINOSUM	!	!	!
Xanthium strumarium	X. chinense, X. inflexum, X. italicum, X. pensylvanicum, X. speciosum, X. varians & X. wootonii	!	as vars. canadense & glabratum
Xyris jupicai	not included	!	!
Xyris torta	!	!	!
Yucca arkansana	Y. glauca var. mollis	!	!
Yucca glauca	as var. glauca	!	!
YUCCA SMALLIANA	!	!	Y. flaccida
Zannichellia palustris	as var. major	as var. major	!
Zanthoxylum americanum	!	!	!
ZEA MAYS	!	!	!
ZELTNERA CALYCOSA	Centaurium calycosum	!	Centaurium calycosum
Zeltnera texensis	Centaurium texense	!	Centaurium texense
Zigadenus elegans subsp. glaucus	Z. elegans	!	!
Zigadenus nuttallii	!	!	!
ZIZANIA AQUATICA	not included	(Z. palustris var. palustris)	!
Zizania palustris var. interior	Z. aquatica var. interior	!	!
Zizaniopsis miliacea	!	!	!
Zizia aptera	!	!	!
Zizia aurea	!	!	!

ECOLOGICAL CHECKLIST OF THE MISSOURI FLORA

TABLE 3.
Plant families and wetness ratings of the Missouri flora, modified from Lichvar (2012, 2013) and Lichvar et al. (2014). Columns are included for all regions established by Lichvar (2012) that include a portion of Missouri. AGP = Atlantic & Gulf Coastal Plain; EMP = Eastern Mountains and Piedmont; MW = Midwest. Designations in ALL CAPS are from Lichvar (2012, 2013) and Lichvar et al. (2014); those in small case were not ranked and are imputed. The MO column provides an aggregate statewide wetness coefficient and rating for each taxon. In cases where the assigned wetness clearly does not represent the ecology of a taxon in Missouri, we have provided our assessment of the correct rating within brackets. See discussion in text for further explanation.

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
ABUTILON THEOPHRASTI	FACU	UPL	FACU	3	FACU	Malvaceae
Acaciella angustissima	upl	upl	upl	5	UPL	Fabaceae
Acalypha deamii	FAC	FACU	FACU	3	FACU	Euphorbiaceae
Acalypha gracilens	FAC	FAC	FACU	5	[UPL]	Euphorbiaceae
Acalypha monococca	FAC	FAC	FACU	5	[UPL]	Euphorbiaceae
Acalypha ostryifolia	upl	upl	upl	5	UPL	Euphorbiaceae
Acalypha rhomboidea	FAC	FACU	FACU	3	FACU	Euphorbiaceae
Acalypha virginica	FACU	FACU	FACU	3	FACU	Euphorbiaceae
ACER GINNALA	upl	upl	upl	5	UPL	Sapindaceae
Acer negundo	FAC	FAC	FAC	0	FAC	Sapindaceae
Acer rubrum var. drummondii	FAC	FAC	FAC	-5	[OBL]	Sapindaceae
Acer rubrum var. rubrum	FAC	FAC	FAC	0	FAC	Sapindaceae
Acer rubrum var. trilobum	FAC	FAC	FAC	0	FAC	Sapindaceae
Acer saccharinum	FAC	FACW	FACW	-3	FACW	Sapindaceae
Acer saccharum subsp. floridanum	FACU	FACU	FACU	3	FACU	Sapindaceae
Acer saccharum subsp. nigrum	UPL	FACU	FACU	3	FACU	Sapindaceae
Acer saccharum subsp. saccharum	FACU	FACU	FACU	3	FACU	Sapindaceae
Acer saccharum subsp. schneckii	FACU	FACU	FACU	3	FACU	Sapindaceae
Achillea millefolium	FACU	FACU	FACU	3	FACU	Asteraceae
ACHILLEA PTARMICA	FACU	FACU	FACU	3	FACU	Asteraceae
ACHYRANTHES JAPONICA	upl	upl	upl	5	UPL	Amaranthaceae
Acmella oppositifolia	FACW	FACW	FACW	-3	FACW	Asteraceae
Acmispon americanus	FACU	FACU	FACU	3	FACU	Fabaceae
Aconitum uncinatum	FAC	FAC	FAC	0	FAC	Ranunculaceae
ACORUS CALAMUS	OBL	OBL	OBL	-5	OBL	Acoraceae
Actaea pachypoda	FACU	UPL	FACU	3	FACU	Ranunculaceae
Actaea racemosa	upl	upl	upl	5	UPL	Ranunculaceae
ACTINIDIA CHINENSIS var. DELICIOSA	upl	upl	upl	5	UPL	Actinidiaceae
Adiantum capillus-veneris	FACU	FACU	FACU	3	FACU	Pteridaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Adiantum pedatum	FACU	FAC	FACU	3	FACU	Pteridaceae
ADONIS ANNUA	UPL	UPL	UPL	5	UPL	Ranunculaceae
AEGILOPS CYLINDRICA	UPL	UPL	UPL	5	UPL	Poaceae
AESCHYNOMENE INDICA	FACW	FACW	facw	-3	FACW	Fabaceae
AESCHYNOMENE RUDIS	upl	upl	upl	5	UPL	Fabaceae
Aesculus glabra var. glabra	FACU	FACU	FAC	3	FACU	Sapindaceae
Aesculus glabra var. arguta	FACU	FACU	FAC	3	FACU	Sapindaceae
Aesculus pavia	FACU	FAC	FAC	3	FACU	Sapindaceae
Agalinis aspera	FACU	FACU	FACU	3	FACU	Orobanchaceae
Agalinis auriculata	upl	upl	upl	5	UPL	Orobanchaceae
Agalinis fasciculata	FAC	FAC	FAC	0	FAC	Orobanchaceae
Agalinis gattingeri	upl	upl	upl	5	UPL	Orobanchaceae
Agalinis heterophylla	FACU	FACU	FAC	3	FACU	Orobanchaceae
Agalinis purpurea	FACW	FACW	FACW	-3	FACW	Orobanchaceae
Agalinis skinneriana	FACU	FACU	FACU	3	FACU	Orobanchaceae
Agalinis tenuifolia	FACU	FAC	FACW	0	FAC	Orobanchaceae
Agalinis viridis	upl	upl	upl	5	UPL	Orobanchaceae
Agastache nepetoides	FAC	FACU	FACU	3	FACU	Lamiaceae
Agastache scrophulariifolia	upl	upl	upl	5	UPL	Lamiaceae
Ageratina altissima	FACU	FACU	FACU	3	FACU	Asteraceae
AGERATUM CONYZOIDES	FACU	FACU	FACU	3	FACU	Asteraceae
Agrimonia gryposepala	FACU	FACU	FACU	3	FACU	Rosaceae
Agrimonia parviflora	FAC	FACW	FACW	-3	FACW	Rosaceae
Agrimonia pubescens	upl	upl	upl	5	UPL	Rosaceae
Agrimonia rostellata	FAC	FACU	FACU	3	FACU	Rosaceae
AGROPYRON CRISTATUM	upl	upl	upl	5	UPL	Poaceae
AGROSTEMMA GITHAGO	upl	upl	upl	5	UPL	Caryophyllaceae
AGROSTIS CAPILLARIS	FAC	FAC	FAC	0	FAC	Poaceae
Agrostis elliottiana	FACU	FACU	FACU	3	FACU	Poaceae
AGROSTIS GIGANTEA	FACW	FACW	FACW	-3	FACW	Poaceae
Agrostis hyemalis	FAC	FAC	FAC	0	FAC	Poaceae
Agrostis perennans var. aestivalis	FACU	FACU	FAC	-3	[FACW]	Poaceae
Agrostis perennans var. perennans	FACU	FACU	FAC	3	FACU	Poaceae
AGROSTIS STOLONIFERA	FACW	FACW	FACW	-3	FACW	Poaceae
AILANTHUS ALTISSIMA	upl	upl	upl	5	UPL	Simaroubaceae
AIRA CARYOPHYLLEA	FAC	FAC	FACU	3	FACU	Poaceae
AIRA ELEGANS	upl	upl	upl	5	UPL	Poaceae
AJUGA REPTANS	upl	upl	upl	5	UPL	Lamiaceae
AKEBIA QUINATA	upl	upl	upl	5	UPL	Lardizabalaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
ALBIZIA JULIBRISSIN	upl	upl	upl	5	UPL	Fabaceae
ALCEA ROSEA	upl	upl	upl	5	UPL	Malvaceae
Alisma gramineum	OBL	OBL	OBL	-5	OBL	Alismataceae
Alisma subcordatum	OBL	OBL	OBL	-5	OBL	Alismataceae
Alisma triviale	OBL	OBL	OBL	-5	OBL	Alismataceae
ALLIARIA PETIOLATA	FACU	FACU	FAC	3	FACU	Brassicaceae
Allium burdickii	facu	facu	facu	3	FACU	Liliaceae
Allium canadense	FACU	FACU	FACU	3	FACU	Liliaceae
ALLIUM CEPA	upl	upl	upl	5	UPL	Liliaceae
Allium cernuum	FACU	FACU	FACU	3	FACU	Liliaceae
Allium mutabile	FACU	FACU	FACU	5	[UPL]	Liliaceae
ALLIUM SATIVUM	upl	upl	upl	5	UPL	Liliaceae
Allium stellatum	upl	upl	upl	5	UPL	Liliaceae
Allium tricoccum	FACU	FACU	FACU	3	FACU	Liliaceae
ALLIUM TUBEROSUM	upl	upl	upl	5	UPL	Liliaceae
ALLIUM VINEALE	FACU	FACU	FACU	3	FACU	Liliaceae
ALNUS GLUTINOSA	FACW	FACW	FACW	-3	FACW	Betulaceae
Alnus serrulata	FACW	OBL	OBL	-5	OBL	Betulaceae
Alopecurus aequalis	OBL	OBL	OBL	-5	OBL	Poaceae
Alopecurus carolinianus	FACW	FACW	FACW	-3	FACW	Poaceae
ALOPECURUS PRATENSIS	FAC	FACW	FACW	-3	FACW	Poaceae
ALYSSUM ALYSSOIDES	upl	upl	upl	5	UPL	Brassicaceae
ALYSSUM DESERTORUM	upl	upl	upl	5	UPL	Brassicaceae
Amaranthus albus	FACU	FACU	FACU	3	FACU	Amaranthaceae
AMARANTHUS ARENICOLA	FACU	UPL	FACU	3	FACU	Amaranthaceae
AMARANTHUS BLITOIDES	FAC	FAC	FACU	3	FACU	Amaranthaceae
AMARANTHUS BLITUM var. EMARGINATUS	FACU	FACU	FAC	3	FACU	Amaranthaceae
AMARANTHUS CAUDATUS	upl	upl	upl	5	UPL	Amaranthaceae
AMARANTHUS CRUENTUS	upl	upl	upl	5	UPL	Amaranthaceae
Amaranthus hybridus	upl	upl	upl	5	UPL	Amaranthaceae
AMARANTHUS HYPOCHONDRIACUS	upl	upl	upl	5	UPL	Amaranthaceae
AMARANTHUS PALMERI	FACU	FACU	FACU	3	FACU	Amaranthaceae
AMARANTHUS POWELLII	upl	upl	upl	5	UPL	Amaranthaceae
AMARANTHUS RETROFLEXUS	FAC	FACU	FACU	3	FACU	Amaranthaceae
AMARANTHUS SPINOSUS	FACU	FACU	FACU	3	FACU	Amaranthaceae
AMARANTHUS TRICOLOR	UPL	UPL	UPL	5	UPL	Amaranthaceae
Amaranthus tuberculatus	FACW	FACW	OBL	-3	FACW	Amaranthaceae
AMARANTHUS VIRIDIS	FAC	FAC	FAC	0	FAC	Amaranthaceae
AMBROSIA ACANTHICARPA	upl	upl	upl	5	UPL	Asteraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Ambrosia artemisiifolia	FACU	FACU	FACU	3	FACU	Asteraceae
Ambrosia bidentata	upl	upl	upl	5	UPL	Asteraceae
Ambrosia psilostachya	FAC	FAC	FACU	3	FACU	Asteraceae
AMBROSIA TOMENTOSA	upl	upl	upl	5	UPL	Asteraceae
Ambrosia trifida	FAC	FAC	FAC	0	FAC	Asteraceae
Amelanchier arborea	FACU	FAC	FACU	3	FACU	Rosaceae
AMELANCHIER HUMILIS	upl	upl	upl	5	UPL	Rosaceae
Amianthium muscitoxicum	FAC	FAC	FAC	0	FAC	Liliaceae
Ammannia coccinea	OBL	OBL	OBL	-5	OBL	Lythraceae
Ammannia robusta	OBL	OBL	OBL	-5	OBL	Lythraceae
AMMI MAJUS	upl	upl	upl	5	UPL	Apiaceae
AMMOSELINUM BUTLERI	FAC	FAC	FAC	0	FAC	Apiaceae
Amorpha canescens	upl	upl	upl	5	UPL	Fabaceae
Amorpha fruticosa	FACW	FACW	FACW	-3	FACW	Fabaceae
Amorpha nitens	FAC	FAC	FACW	0	FAC	Fabaceae
Ampelopsis arborea	FAC	FACW	FACW	-3	FACW	Vitaceae
AMPELOPSIS BREVIPEDUNCULATA	upl	upl	upl	5	UPL	Vitaceae
Ampelopsis cordata	FAC	FAC	FAC	0	FAC	Vitaceae
Amphiachyris dracunculoides	upl	upl	upl	5	UPL	Asteraceae
Amphicarpaea bracteata	FAC	FAC	FAC	0	FAC	Fabaceae
AMSINCKIA LYCOPSOIDES	upl	upl	upl	5	UPL	Boraginaceae
AMSINCKIA MENZIESII	upl	upl	upl	5	UPL	Boraginaceae
AMSINCKIA TESSELLATA	upl	upl	upl	5	UPL	Boraginaceae
Amsonia ciliata var. filifolia	upl	upl	upl	5	UPL	Apocynaceae
Amsonia illustris	FAC	FAC	FAC	0	FAC	Apocynaceae
Amsonia tabernaemontana var. salicifolia	FACW	FACW	FACW	-3	FACW	Apocynaceae
Amsonia tabernaemontana var. tabernaemontana	FACW	FACW	FACW	-3	FACW	Apocynaceae
ANAGALLIS ARVENSIS	upl	upl	upl	5	UPL	Primulaceae
Anagallis minima	upl	upl	upl	5	UPL	Primulaceae
ANAPHALIS MARGARITACEA	UPL	UPL	UPL	5	UPL	Asteraceae
ANCHUSA AZUREA	upl	upl	upl	5	UPL	Boraginaceae
ANCHUSA OFFICINALIS	upl	upl	upl	5	UPL	Boraginaceae
Andrachne phyllanthoides	upl	upl	upl	5	UPL	Euphorbiaceae
Andropogon gerardii	FAC	FAC	FAC	0	FAC	Poaceae
Andropogon gyrans	FAC	OBL	UPL	5	[UPL]	Poaceae
Andropogon ternarius	FACU	FACU	FACU	3	FACU	Poaceae
Andropogon virginicus	FAC	FACU	FACU	3	FACU	Poaceae
Androsace occidentalis	FACU	FACU	FACU	3	FACU	Primulaceae
Anemone acutiloba	upl	upl	upl	5	UPL	Ranunculaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Anemone americana	upl	upl	upl	5	UPL	Ranunculaceae
Anemone canadensis	FAC	FACW	FACW	-3	FACW	Ranunculaceae
Anemone caroliniana	upl	upl	upl	5	UPL	Ranunculaceae
Anemone cylindrica	upl	upl	upl	5	UPL	Ranunculaceae
Anemone quinquefolia	FACU	FACU	FAC	3	FACU	Ranunculaceae
Anemone virginiana	FACU	FACU	FACU	3	FACU	Ranunculaceae
ANETHUM GRAVEOLENS	upl	upl	upl	5	UPL	Apiaceae
Angelica venenosa	upl	upl	upl	5	UPL	Apiaceae
ANODA CRISTATA	FAC	UPL	FAC	3	FACU	Malvaceae
Antennaria neglecta	UPL	UPL	UPL	5	UPL	Asteraceae
Antennaria parlinii	upl	upl	upl	5	UPL	Asteraceae
ANTHEMIS ARVENSIS	upl	upl	upl	5	UPL	Asteraceae
ANTHEMIS COTULA	FACU	FACU	FACU	3	FACU	Asteraceae
ANTHOXANTHUM ODORATUM	FACU	FACU	FACU	3	FACU	Poaceae
ANTHRISCUS CAUCALIS	upl	upl	upl	5	UPL	Apiaceae
ANTIRRHINUM MAJUS	upl	upl	upl	5	UPL	Plantaginaceae
APERA INTERRUPTA	upl	upl	upl	5	UPL	Poaceae
APERA SPICA-VENTI	upl	upl	upl	5	UPL	Poaceae
APHANES AUSTRALIS	upl	upl	upl	5	UPL	Rosaceae
APHANOSTEPHUS SKIRRHOBASIS	upl	upl	upl	5	UPL	Asteraceae
Apios americana	FACW	FACW	FACW	-3	FACW	Fabaceae
APIUM GRAVEOLENS	upl	upl	upl	5	UPL	Apiaceae
Aplectrum hyemale	FAC	FAC	FAC	0	FAC	Orchidaceae
Apocynum × floribundum	upl	upl	upl	5	UPL	Apocynaceae
Apocynum androsaemifolium	UPL	FACU	UPL	5	UPL	Apocynaceae
Apocynum cannabinum	FACU	FACU	FAC	3	FACU	Apocynaceae
Apocynum sibiricum	FACU	FACU	FAC	3	FACU	Apocynaceae
Aquilegia canadensis	FACU	FAC	FACU	3	FACU	Ranunculaceae
Arabidopsis lyrata	FACU	FACU	FACU	3	FACU	Brassicaceae
ARABIDOPSIS THALIANA	upl	upl	upl	5	UPL	Brassicaceae
Arabis hirsuta	FACU	FACU	FACU	3	FACU	Brassicaceae
ARACHIS HYPOGAEA	upl	upl	upl	5	UPL	Fabaceae
ARALIA ELATA	upl	upl	upl	5	UPL	Araliaceae
Aralia nudicaulis	FACU	FACU	FACU	3	FACU	Araliaceae
Aralia racemosa	FACU	FACU	FACU	3	FACU	Araliaceae
Aralia spinosa	FAC	FAC	FACW	0	FAC	Araliaceae
ARCTIUM MINUS	UPL	FACU	FACU	3	FACU	Asteraceae
ARENARIA SERPYLLIFOLIA	UPL	FAC	FAC	3	FACU	Caryophyllaceae
ARGEMONE ALBIFLORA	upl	upl	upl	5	UPL	Papaveraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
ARGEMONE MEXICANA	upl	upl	upl	5	UPL	Papaveraceae
Argyrochosma dealbata	upl	upl	upl	5	UPL	Pteridaceae
Arisaema dracontium	FACW	FACW	FACW	-3	FACW	Araceae
Arisaema triphyllum	FACW	FACW	FACW	-3	FACW	Araceae
Aristida adscensionis	upl	upl	upl	5	UPL	Poaceae
Aristida basiramea	upl	upl	upl	5	UPL	Poaceae
Aristida desmantha	upl	upl	upl	5	UPL	Poaceae
Aristida dichotoma var. curtissii	FACU	UPL	FACU	5	UPL	Poaceae
Aristida dichotoma var. dichotoma	FACU	UPL	FACU	5	UPL	Poaceae
Aristida lanosa	upl	upl	upl	5	UPL	Poaceae
Aristida longespica var. geniculata	FACU	UPL	FACU	5	UPL	Poaceae
Aristida longespica var. longespica	FACU	UPL	FACU	5	UPL	Poaceae
Aristida oligantha	upl	upl	upl	5	UPL	Poaceae
Aristida purpurascens	FACW	FAC	FACU	0	FAC	Poaceae
Aristida ramosissima	upl	upl	upl	5	UPL	Poaceae
Aristolochia serpentaria var. hastata	upl	upl	upl	5	UPL	Aristolochiaceae
Aristolochia serpentaria var. serpentaria	upl	upl	upl	5	UPL	Aristolochiaceae
Aristolochia tomentosa	upl	upl	upl	5	UPL	Aristolochiaceae
ARMORACIA RUSTICANA	upl	upl	upl	5	UPL	Brassicaceae
Arnoglossum atriplicifolium	upl	upl	upl	5	UPL	Asteraceae
Arnoglossum plantagineum	FACU	FACW	FAC	0	FAC	Asteraceae
Arnoglossum reniforme	upl	upl	upl	5	UPL	Asteraceae
Aronia melanocarpa	FAC	FAC	FACW	0	FAC	Rosaceae
ARRHENATHERUM ELATIUS	FACU	FACU	FACU	3	FACU	Poaceae
ARTEMISIA ABSINTHIUM	upl	upl	upl	5	UPL	Asteraceae
ARTEMISIA ANNUA	FACU	FACU	FACU	3	FACU	Asteraceae
ARTEMISIA BIENNIS	FACU	FACU	FACW	0	FAC	Asteraceae
Artemisia campestris subsp. caudata	UPL	UPL	UPL	5	UPL	Asteraceae
ARTEMISIA CARRUTHII	upl	upl	upl	5	UPL	Asteraceae
Artemisia dracunculus	upl	upl	upl	5	UPL	Asteraceae
ARTEMISIA FRIGIDA	upl	upl	upl	5	UPL	Asteraceae
Artemisia ludoviciana var. ludoviciana	UPL	UPL	UPL	5	UPL	Asteraceae
Artemisia ludoviciana var. mexicana	UPL	UPL	UPL	5	UPL	Asteraceae
ARTEMISIA STELLARIANA	FACU	FACU	FACU	3	FACU	Asteraceae
ARTEMISIA VULGARIS	UPL	UPL	UPL	5	UPL	Asteraceae
ARTHRAXON HISPIDUS	FAC	FAC	FACW	0	FAC	Poaceae
ARUM ITALICUM	upl	upl	upl	3	[FACU]	Araceae
Aruncus dioicus var. pubescens	FACU	FACU	FACU	3	FACU	Rosaceae
Arundinaria gigantea	FACW	FACW	FACW	-3	FACW	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
ARUNDO DONAX	FAC	FACU	FACW	0	FAC	Poaceae
Asarum canadense	UPL	FACU	FACU	3	FACU	Aristolochiaceae
Asclepias amplexicaulis	upl	upl	upl	5	UPL	Asclepiadaceae
Asclepias exaltata	UPL	FACU	UPL	5	UPL	Asclepiadaceae
Asclepias hirtella	UPL	UPL	UPL	5	UPL	Asclepiadaceae
Asclepias incarnata	OBL	OBL	OBL	-5	OBL	Asclepiadaceae
Asclepias meadii	upl	upl	upl	5	UPL	Asclepiadaceae
Asclepias perennis	OBL	OBL	OBL	-5	OBL	Asclepiadaceae
Asclepias purpurascens	FACU	FACU	FACU	3	FACU	Asclepiadaceae
Asclepias quadrifolia	upl	upl	upl	5	UPL	Asclepiadaceae
ASCLEPIAS SPECIOSA	FAC	FAC	FAC	0	FAC	Asclepiadaceae
Asclepias stenophylla	upl	upl	upl	5	UPL	Asclepiadaceae
ASCLEPIAS SUBVERTICILLATA	FACU	FACU	FACU	3	FACU	Asclepiadaceae
Asclepias sullivantii	upl	upl	upl	5	UPL	Asclepiadaceae
Asclepias syriaca	UPL	FACU	FACU	3	FACU	Asclepiadaceae
Asclepias tuberosa subsp. interior	upl	upl	upl	5	UPL	Asclepiadaceae
Asclepias variegata	FACU	FACU	FACU	3	FACU	Asclepiadaceae
Asclepias verticillata	FACU	FACU	FACU	5	[UPL]	Asclepiadaceae
Asclepias viridiflora	upl	upl	upl	5	UPL	Asclepiadaceae
Asclepias viridis	upl	upl	upl	5	UPL	Asclepiadaceae
Asimina triloba	FAC	FAC	FAC	0	FAC	Annonaceae
ASPARAGUS OFFICINALIS	FACU	FACU	FACU	3	FACU	Liliaceae
ASPARAGUS SPRENGERI	upl	upl	upl	5	UPL	Liliaceae
Asplenium × ebenoides	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium × gravesii	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium bradleyi	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium montanum	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium pinnatifidum	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium platyneuron	FACU	FACU	FACU	3	FACU	Aspleniaceae
Asplenium resiliens	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium rhizophyllum	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium ruta-muraria	upl	upl	upl	5	UPL	Aspleniaceae
Asplenium trichomanes	FAC	FAC	UPL	5	UPL	Aspleniaceae
ASTER TATARICUS	upl	upl	upl	5	UPL	Asteraceae
Astragalus canadensis	FAC	FAC	FAC	0	FAC	Fabaceae
Astragalus crassicarpus var. crassicarpus	upl	upl	upl	5	UPL	Fabaceae
Astragalus crassicarpus var. trichocalyx	upl	upl	upl	5	UPL	Fabaceae
Astragalus distortus	upl	upl	upl	5	UPL	Fabaceae
Astragalus lotiflorus	upl	upl	upl	5	UPL	Fabaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Astranthium ciliatum	upl	upl	upl	5	UPL	Asteraceae
Athyrium filix-femina	FAC	FAC	FAC	0	FAC	Dryopteridaceae
ATOCION ARMERIA	upl	upl	upl	5	UPL	Caryophyllaceae
ATRIPLEX ARGENTEA	fac	FAC	FAC	0	FAC	Chenopodiaceae
ATRIPLEX HORTENSIS	FACU	UPL	FAC	3	FACU	Chenopodiaceae
ATRIPLEX MICRANTHA	upl	upl	upl	5	UPL	Chenopodiaceae
ATRIPLEX PATULA	FACW	FACW	FACW	-3	FACW	Chenopodiaceae
ATRIPLEX PROSTRATA	FACW	FACW	FAC	0	FAC	Chenopodiaceae
ATRIPLEX ROSEA	FACU	FACU	FACU	3	FACU	Chenopodiaceae
ATRIPLEX TRUNCATA	facu	FACU	FACU	3	FACU	Chenopodiaceae
ATRIPLEX WRIGHTII	upl	upl	upl	5	UPL	Chenopodiaceae
AUBRIETA DELTOIDEA	upl	upl	upl	5	UPL	Brassicaceae
Aureolaria flava var. calycosa	upl	upl	upl	5	UPL	Orobanchaceae
Aureolaria flava var. flava	upl	upl	upl	5	UPL	Orobanchaceae
Aureolaria grandiflora var. pulchra	upl	upl	upl	5	UPL	Orobanchaceae
Aureolaria grandiflora var. serrata	upl	upl	upl	5	UPL	Orobanchaceae
Aureolaria pectinata	upl	upl	upl	5	UPL	Orobanchaceae
AVENA FATUA var. FATUA	upl	upl	upl	5	UPL	Poaceae
AVENA FATUA var. SATIVA	UPL	UPL	UPL	5	UPL	Poaceae
AXYRIS AMARANTHOIDES	upl	upl	upl	5	UPL	Chenopodiaceae
Azolla caroliniana	OBL	OBL	OBL	-5	OBL	Azollaceae
Azolla mexicana	OBL	OBL	OBL	-5	OBL	Azollaceae
BACCHARIS WRIGHTII	facu	facu	facu	3	FACU	Asteraceae
Bacopa rotundifolia	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Baptisia alba var. macrophylla	FACU	FACU	FACU	3	FACU	Fabaceae
Baptisia australis var. minor	FACU	FACU	FACU	5	[UPL]	Fabaceae
Baptisia bracteata var. leucophaea	upl	upl	upl	5	UPL	Fabaceae
BAPTISIA SPHAEROCARPA	upl	upl	upl	5	UPL	Fabaceae
BARBAREA VERNA	upl	upl	upl	5	UPL	Brassicaceae
BARBAREA VULGARIS	FAC	FACU	FAC	3	FACU	Brassicaceae
Bartonia paniculata	OBL	OBL	OBL	-5	OBL	Gentianaceae
Bartonia virginica	FACW	FACW	FACW	-3	FACW	Gentianaceae
BELAMCANDA CHINENSIS	upl	upl	upl	5	UPL	Iridaceae
Berberis canadensis	upl	upl	upl	5	UPL	Berberidaceae
BERBERIS THUNBERGII	UPL	FACU	FACU	3	FACU	Berberidaceae
BERBERIS VULGARIS	UPL	FACU	FACU	3	FACU	Berberidaceae
Berchemia scandens	FAC	FACW	FAC	0	FAC	Rhamnaceae
Bergia texana	OBL	OBL	OBL	-5	OBL	Elatinaceae
Berlandiera texana	upl	upl	upl	5	UPL	Asteraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
BERTEROA INCANA	upl	upl	upl	5	UPL	Brassicaceae
Berula erecta	obl	obl	OBL	-5	OBL	Apiaceae
BETA VULGARIS	upl	upl	upl	5	UPL	Chenopodiaceae
Betula nigra	FACW	FACW	FACW	-3	FACW	Betulaceae
BIDENS ALBA var. RADIATA	upl	upl	upl	5	UPL	Asteraceae
Bidens aristosa	FACW	FACW	FACW	-3	FACW	Asteraceae
Bidens beckii	obl	OBL	OBL	-5	OBL	Asteraceae
BIDENS BIPINNATA	FAC	FACU	FAC	3	FACU	Asteraceae
Bidens cernua	OBL	OBL	OBL	-5	OBL	Asteraceae
Bidens comosa	FACW	FACW	OBL	-3	FACW	Asteraceae
Bidens connata	FACW	FACW	OBL	-3	FACW	Asteraceae
Bidens discoidea	FACW	FACW	FACW	-3	FACW	Asteraceae
Bidens frondosa	FACW	FACW	FACW	-3	FACW	Asteraceae
Bidens laevis	OBL	OBL	OBL	-5	OBL	Asteraceae
Bidens polylepis	FACW	FACW	FACW	-3	FACW	Asteraceae
BIDENS TRICHOSPERMA	OBL	OBL	OBL	-5	OBL	Asteraceae
Bidens vulgata	OBL	FAC	FACW	0	FAC	Asteraceae
Bignonia capreolata	FAC	FAC	FACW	-3	FACW	Bignoniaceae
Blephilia ciliata	upl	upl	upl	5	UPL	Lamiaceae
Blephilia hirsuta	FACU	FACU	FACU	3	FACU	Lamiaceae
Boechera canadensis	upl	upl	upl	5	UPL	Brassicaceae
Boechera laevigata	upl	upl	upl	5	UPL	Brassicaceae
Boechera missouriensis	upl	upl	upl	5	UPL	Brassicaceae
Boechera shortii	FACU	FACU	UPL	3	FACU	Brassicaceae
Boehmeria cylindrica	FACW	FACW	OBL	-5	OBL	Urticaceae
BOERHAAVIA ERECTA	UPL	UPL	UPL	5	UPL	Nyctaginaceae
Bolboschoenus fluviatilis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Bolboschoenus maritimus subsp. paludosus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Boltonia asteroides	FACW	FACW	OBL	-3	FACW	Asteraceae
Boltonia decurrens	obl	obl	obl	-5	OBL	Asteraceae
Boltonia diffusa	FACW	FAC	FACW	-3	FACW	Asteraceae
BOTHRIOCHLOA BLADHII	FACU	FACU	FACU	3	FACU	Poaceae
BOTHRIOCHLOA ISCHAEMUM	upl	upl	upl	5	UPL	Poaceae
Bothriochloa laguroides subsp. torreyana	upl	upl	upl	5	UPL	Poaceae
Botrychium biternatum	upl	upl	upl	5	UPL	Ophioglossaceae
Botrychium dissectum	upl	upl	upl	5	UPL	Ophioglossaceae
Botrychium virginianum	upl	upl	upl	5	UPL	Ophioglossaceae
Bouteloua curtipendula	UPL	UPL	UPL	5	UPL	Poaceae
Bouteloua gracilis	upl	upl	upl	5	UPL	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Bouteloua hirsuta	upl	upl	upl	5	UPL	Poaceae
BRACHIARIA ERUCIFORMIS	upl	upl	upl	5	UPL	Poaceae
Brachyelytrum erectum	FACU	FACU	FACU	3	FACU	Poaceae
Bradburia pilosa	upl	upl	upl	5	UPL	Asteraceae
Brasenia schreberi	OBL	OBL	OBL	-5	OBL	Cabombaceae
BRASSICA JUNCEA	UPL	UPL	UPL	5	UPL	Brassicaceae
BRASSICA NAPUS	upl	upl	upl	5	UPL	Brassicaceae
BRASSICA NIGRA	upl	upl	upl	5	UPL	Brassicaceae
BRASSICA RAPA	UPL	UPL	UPL	5	UPL	Brassicaceae
Brickellia eupatorioides var. eupatorioides	upl	upl	upl	5	UPL	Asteraceae
Brickellia eupatorioides var. texana	upl	upl	upl	5	UPL	Asteraceae
Brickellia grandiflora	upl	upl	upl	5	UPL	Asteraceae
BROMUS COMMUTATUS	upl	upl	upl	5	UPL	Poaceae
BROMUS DIANDRUS	upl	upl	upl	5	UPL	Poaceae
BROMUS HORDACEUS	UPL	UPL	UPL	5	UPL	Poaceae
BROMUS INERMIS	UPL	UPL	FACU	5	UPL	Poaceae
BROMUS JAPONICUS	FACU	FACU	FACU	3	FACU	Poaceae
Bromus latiglumis	FACW	FACW	FACW	-3	FACW	Poaceae
Bromus nottowayanus	upl	upl	upl	5	UPL	Poaceae
Bromus pubescens	FACU	FACU	FACU	5	[UPL]	Poaceae
BROMUS RACEMOSUS	upl	upl	upl	5	UPL	Poaceae
BROMUS SECALINUS	upl	upl	upl	5	UPL	Poaceae
BROMUS SQUARROSUS	upl	upl	upl	5	UPL	Poaceae
BROMUS STERILIS	upl	upl	upl	5	UPL	Poaceae
BROMUS TECTORUM	upl	upl	upl	5	UPL	Poaceae
BROMUS WILLDENOWII	upl	upl	upl	5	UPL	Poaceae
BROUSSONETIA PAPYRIFERA	FACU	UPL	FACU	3	FACU	Moraceae
BRUNNERA MACROPHYLLA	upl	upl	upl	5	UPL	Boraginaceae
Brunnichia ovata	FACW	FACW	FACW	-3	FACW	Polygonaceae
Buchloe dactyloides	FACU	FACU	FACU	3	FACU	Poaceae
Buchnera americana	FAC	FACU	FAC	3	FACU	Orobanchaceae
BUDDLEJA DAVIDII	FACU	FACU	FACU	3	FACU	Scrophulariaceae
BUGLOSSOIDES ARVENSE	upl	upl	upl	5	UPL	Boraginaceae
Bulbostylis capillaris	FAC	FACU	FACU	3	FACU	Cyperaceae
BUPLEURUM ROTUNDIFOLIUM	upl	upl	upl	5	UPL	Apiaceae
Cabomba caroliniana	OBL	OBL	OBL	-5	OBL	Cabombaceae
Calamagrostis canadensis	OBL	FACW	OBL	-5	OBL	Poaceae
Calamagrostis porteri subsp. insperata	UPL	UPL	UPL	5	UPL	Poaceae
Calamagrostis stricta subsp. inexpansa	FACW	FACW	FACW	-3	FACW	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
CALAMOVILFA LONGIFOLIA	upl	upl	upl	5	UPL	Poaceae
Callicarpa americana	FACU	FACU	FACU	3	FACU	Lamiaceae
CALLICARPA DICHOTOMA	OBL	OBL	[fac]	0	[FAC]	Lamiaceae
Callirhoe alcaeoides	upl	upl	upl	5	UPL	Malvaceae
Callirhoe bushii	upl	upl	upl	5	UPL	Malvaceae
Callirhoe digitata	upl	upl	upl	5	UPL	Malvaceae
Callirhoe involucrata	upl	upl	upl	5	UPL	Malvaceae
Callirhoe triangulata	upl	upl	upl	5	UPL	Malvaceae
Callitriche heterophylla	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Callitriche palustris	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Callitriche terrestris	FACW	FACW	FACW	-3	FACW	Plantaginaceae
Calopogon oklahomensis	upl	upl	upl	3	[FACU]	Orchidaceae
Calopogon tuberosus	OBL	FACW	OBL	-5	OBL	Orchidaceae
Caltha palustris	OBL	OBL	OBL	-5	OBL	Ranunculaceae
CALYCANTHUS FLORIDUS	FACU	FACU	FACU	3	FACU	Calycanthaceae
Calycocarpum lyonii	FACW	FACW	FACW	-3	FACW	Menispermaceae
Calylophus serrulatus	upl	upl	upl	5	UPL	Onagraceae
Calystegia macounii	upl	upl	upl	5	UPL	Convolvulaceae
CALYSTEGIA PUBESCENS	upl	upl	upl	5	UPL	Convolvulaceae
Calystegia sepium	FAC	FAC	FAC	0	FAC	Convolvulaceae
Calystegia silvatica subsp. fraterniflora	upl	upl	upl	5	UPL	Convolvulaceae
Calystegia spithamaea	upl	upl	upl	5	UPL	Convolvulaceae
Camassia angusta	upl	upl	upl	5	UPL	Liliaceae
Camassia scilloides	FACW	FAC	FAC	3	[FACU]	Liliaceae
CAMELINA MICROCARPA	FACU	FACU	FACU	3	FACU	Brassicaceae
CAMELINA SATIVA	FACU	UPL	FACU	5	UPL	Brassicaceae
Campanula americana	FAC	FACU	FAC	0	FAC	Campanulaceae
Campanula aparinoides	OBL	OBL	OBL	-5	OBL	Campanulaceae
CAMPANULA RAPUNCULOIDES	upl	upl	upl	5	UPL	Campanulaceae
Campanula rotundifolia	FACU	FACU	FACU	3	FACU	Campanulaceae
Campsis radicans	FAC	FAC	FACU	0	FAC	Bignoniaceae
CANAVALIA ENSIFORMIS	upl	upl	upl	5	UPL	Fabaceae
CANNABIS SATIVA	FACU	FACU	FACU	3	FACU	Cannabaceae
CAPSELLA BURSA-PASTORIS	FACU	FACU	FACU	3	FACU	Brassicaceae
CAPSICUM ANNUUM	upl	upl	upl	5	UPL	Solanaceae
Cardamine bulbosa	OBL	OBL	OBL	-5	OBL	Brassicaceae
Cardamine concatenata	FACU	FACU	FACU	3	FACU	Brassicaceae
Cardamine diphylla	UPL	FACU	FACU	5	UPL	Brassicaceae
Cardamine douglasii	OBL	FACW	FACW	-3	FACW	Brassicaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
CARDAMINE FLEXUOSA	FACU	OBL	FACU	3	FACU	Brassicaceae
CARDAMINE HIRSUTA	FACU	FACU	FACU	3	FACU	Brassicaceae
Cardamine parviflora var. arenicola	FACU	FACU	FAC	3	FACU	Brassicaceae
Cardamine pensylvanica	FACW	OBL	FACW	-3	FACW	Brassicaceae
CARDIOSPERMUM HALICACABUM	FAC	FACU	FAC	0	FAC	Sapindaceae
CARDUUS CRISPUS	upl	upl	upl	5	UPL	Asteraceae
CARDUUS NUTANS	UPL	UPL	FACU	5	UPL	Asteraceae
Carex × deamii	upl	upl	upl	5	UPL	Cyperaceae
Carex × subimpressa	obl	obl	OBL	-5	OBL	Cyperaceae
Carex abscondita	FACW	FAC	FACU	0	FAC	Cyperaceae
Carex aggregata	upl	upl	upl	5	UPL	Cyperaceae
Carex alata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex albicans var. albicans	FAC	UPL	UPL	5	UPL	Cyperaceae
Carex albicans var. australis	FAC	UPL	UPL	5	UPL	Cyperaceae
Carex albolutescens	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex albursina	upl	upl	upl	5	UPL	Cyperaceae
Carex amphibola	FACW	FAC	FAC	0	FAC	Cyperaceae
Carex annectens var. annectens	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex annectens var. xanthocarpa	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex aquatilis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex arkansana	FACU	FACU	FAC	-3	[FACW]	Cyperaceae
Carex atherodes	obl	OBL	OBL	-5	OBL	Cyperaceae
Carex atlantica	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex aureolensis	facw	facw	facw	-3	FACW	Cyperaceae
Carex austrina	FACU	FACU	FACU	3	FACU	Cyperaceae
Carex bicknellii	FAC	FAC	FACU	3	FACU	Cyperaceae
Carex blanda	FAC	FAC	FAC	0	FAC	Cyperaceae
Carex brevior	OBL	UPL	FAC	0	FAC	Cyperaceae
Carex bromoides	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex bushii	FACW	FACW	FAC	3	[FACU]	Cyperaceae
Carex buxbaumii	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex careyana	upl	upl	upl	5	UPL	Cyperaceae
Carex caroliniana	FACW	FACU	FACW	-3	FACW	Cyperaceae
Carex cephalophora	FAC	FACU	FACU	3	FACU	Cyperaceae
Carex cherokeensis	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex communis	upl	upl	upl	5	UPL	Cyperaceae
Carex comosa	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex complanata	FAC	FACU	FACU	3	FACU	Cyperaceae
Carex conjuncta	FAC	FACW	FACW	-3	FACW	Cyperaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Carex conoidea	FACW	FACU	FACW	-3	FACW	Cyperaceae
Carex corrugata	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex crawei	OBL	FACW	FACW	3	[FACU]	Cyperaceae
CAREX CRAWFORDII	FAC	FAC	FAC	0	FAC	Cyperaceae
Carex crinita	FACW	OBL	OBL	-5	OBL	Cyperaceae
Carex cristatella	FAC	FACW	FACW	-3	FACW	Cyperaceae
Carex crus-corvi	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex cumberlandensis	upl	upl	upl	5	UPL	Cyperaceae
Carex davisii	FAC	FAC	FAC	0	FAC	Cyperaceae
Carex debilis	FACW	FAC	FACW	-3	FACW	Cyperaceae
Carex decomposita	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex digitalis	FACU	UPL	UPL	5	UPL	Cyperaceae
CAREX DOUGLASII	fac	FAC	FAC	0	FAC	Cyperaceae
Carex eburnea	FACU	FACU	FACU	3	FACU	Cyperaceae
CAREX ELEOCHARIS	upl	upl	upl	5	UPL	Cyperaceae
Carex emoryi	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex festucacea	FACW	FAC	FACW	0	FAC	Cyperaceae
Carex fissa	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex flaccosperma	FACW	FAC	FACW	-3	FACW	Cyperaceae
Carex frankii	OBL	OBL	OBL	0	[FAC]	Cyperaceae
Carex gigantea	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex glaucodea	FACW	FAC	FAC	3	[FACU]	Cyperaceae
Carex gracilescens	upl	upl	upl	5	UPL	Cyperaceae
Carex gracillima	FACU	FACU	FACU	3	FACU	Cyperaceae
Carex granularis	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex gravida	FACW	FACW	FACU	0	FAC	Cyperaceae
Carex grayii	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex grisea	FACW	FACU	FAC	0	FAC	Cyperaceae
Carex haydenii	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex hirsutella	upl	upl	upl	5	UPL	Cyperaceae
Carex hirtifolia	upl	upl	upl	5	UPL	Cyperaceae
Carex hitchcockiana	upl	upl	upl	5	UPL	Cyperaceae
Carex hyalinolepis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex hystericina	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex inops subsp. heliophila	upl	upl	upl	5	UPL	Cyperaceae
Carex interior	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex intumescens	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex jamesii	upl	upl	upl	5	UPL	Cyperaceae
Carex joorii	OBL	OBL	obl	-5	OBL	Cyperaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Carex lacustris	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex laeviconica	obl	OBL	OBL	-5	OBL	Cyperaceae
Carex laevivaginata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex laxiculmis var. copulata	upl	upl	upl	5	UPL	Cyperaceae
Carex laxiculmis var. laxiculmis	upl	upl	upl	5	UPL	Cyperaceae
Carex laxiflora	FACU	FACU	UPL	3	FACU	Cyperaceae
Carex leavenworthii	upl	upl	upl	5	UPL	Cyperaceae
Carex leptalea	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex longii	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex louisianica	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex lupuliformis	OBL	FACW	OBL	-5	OBL	Cyperaceae
Carex lupulina	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex lurida	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex meadii	FAC	FAC	FAC	0	FAC	Cyperaceae
Carex mesochorea	FAC	FACU	FACU	3	FACU	Cyperaceae
Carex microdonta	FACW	FACW	FAC	0	FAC	Cyperaceae
Carex missouriensis	[FACW]	[FACW]	[FACW]	-3	[FACW]	Cyperaceae
Carex molesta	FAC	FAC	FAC	0	FAC	Cyperaceae
Carex molestiformis	fac	fac	fac	0	[FAC]	Cyperaceae
Carex muehlenbergii var. enervis	upl	upl	upl	5	UPL	Cyperaceae
Carex muehlenbergii var. muehlenbergii	upl	upl	upl	5	UPL	Cyperaceae
Carex muskingumensis	OBL	OBL	OBL	-5	OBL	Cyperaceae
CAREX NEBRASCENSIS	obl	OBL	OBL	-5	OBL	Cyperaceae
Carex nigromarginata var. floridana	upl	upl	upl	5	UPL	Cyperaceae
Carex nigromarginata var. nigromarginata	FACU	UPL	UPL	5	UPL	Cyperaceae
Carex normalis	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex oklahomensis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex oligocarpa	upl	upl	upl	5	UPL	Cyperaceae
Carex opaca	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex oxylepis	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex pellita	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex pensylvanica	upl	upl	upl	5	UPL	Cyperaceae
Carex planispicata	upl	upl	upl	5	UPL	Cyperaceae
CAREX PRAEGRACILIS	facu	UPL	FACW	0	FAC	Cyperaceae
Carex prasina	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex radiata	FAC	FAC	FAC	0	FAC	Cyperaceae
Carex reniformis	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex retroflexa	FACU	FACU	FACU	3	FACU	Cyperaceae
Carex reznicekii	upl	upl	upl	5	UPL	Cyperaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Carex rosea	FACU	FACU	FACU	3	FACU	Cyperaceae
Carex sartwellii	FACW	OBL	FACW	-5	OBL	Cyperaceae
Carex scabrata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex schweinitzii	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex scoparia	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex shortiana	FACW	FAC	FACW	-3	FACW	Cyperaceae
Carex socialis	upl	upl	upl	5	UPL	Cyperaceae
Carex sparganioides	FAC	FACU	FAC	0	FAC	Cyperaceae
Carex sprengelii	FACU	FACU	FAC	0	FAC	Cyperaceae
Carex squarrosa	FACW	FACW	OBL	-3	FACW	Cyperaceae
Carex sterilis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex stipata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex straminea	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex stricta	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex suberecta	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex swanii	UPL	FACU	FACU	3	FACU	Cyperaceae
Carex sychnocephala	facw	facw	FACW	-3	FACW	Cyperaceae
Carex tenera	FACW	FAC	FACW	-3	FACW	Cyperaceae
Carex tetanica	FACW	FACW	FACW	-3	FACW	Cyperaceae
Carex texensis	upl	upl	upl	5	UPL	Cyperaceae
Carex timida	upl	upl	upl	5	UPL	Cyperaceae
Carex tonsa var. rugosperma	upl	upl	upl	5	UPL	Cyperaceae
Carex tonsa var. tonsa	upl	upl	upl	5	UPL	Cyperaceae
Carex torta	OBL	FACW	OBL	-5	OBL	Cyperaceae
Carex triangularis	FACW	FACW	OBL	-5	OBL	Cyperaceae
Carex tribuloides var. sangamonensis	FACW	FACW	OBL	-3	FACW	Cyperaceae
Carex tribuloides var. tribuloides	FACW	FACW	OBL	-3	FACW	Cyperaceae
Carex trichocarpa	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex typhina	OBL	FACW	OBL	-5	OBL	Cyperaceae
Carex umbellata	upl	upl	upl	5	UPL	Cyperaceae
Carex vesicaria var. monile	OBL	OBL	OBL	-5	OBL	Cyperaceae
Carex virescens	facu	facu	facu	3	FACU	Cyperaceae
Carex vulpinoidea	FACW	OBL	FACW	-3	FACW	Cyperaceae
Carex willdenowii	FACW	UPL	FACU	3	FACU	Cyperaceae
Carex woodii	UPL	UPL	FAC	3	FACU	Cyperaceae
Carpinus caroliniana	FAC	FAC	FAC	0	FAC	Betulaceae
CARUM CARVI	FACU	UPL	FACU	5	UPL	Apiaceae
Carya aquatica	OBL	OBL	OBL	-5	OBL	Juglandaceae
Carya cordiformis	FAC	FACU	FACU	3	FACU	Juglandaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Carya glabra	FACU	FACU	FACU	5	[UPL]	Juglandaceae
Carya illinoinensis	FACU	FACU	FACW	0	FAC	Juglandaceae
Carya laciniosa	FACW	FAC	FACW	-3	FACW	Juglandaceae
Carya ovalis	upl	upl	upl	5	UPL	Juglandaceae
Carya ovata	FACU	FACU	FACU	3	FACU	Juglandaceae
Carya pallida	upl	upl	upl	5	UPL	Juglandaceae
Carya texana	upl	upl	upl	5	UPL	Juglandaceae
Carya tomentosa	upl	upl	upl	5	UPL	Juglandaceae
CASTANEA DENTATA	upl	upl	upl	5	UPL	Fagaceae
CASTANEA MOLLISSIMA	upl	upl	upl	5	UPL	Fagaceae
Castanea pumila var. ozarkensis	upl	upl	upl	5	UPL	Fagaceae
Castanea pumila var. pumila	upl	upl	upl	5	UPL	Fagaceae
Castilleja coccinea	FAC	FAC	FAC	0	FAC	Orobanchaceae
Castilleja purpurea	upl	upl	upl	5	UPL	Orobanchaceae
Castilleja sessiliflora	upl	upl	upl	5	UPL	Orobanchaceae
CATALPA BIGNONIOIDES	UPL	FACU	FACU	3	FACU	Bignoniaceae
CATALPA OVATA	upl	upl	upl	5	UPL	Bignoniaceae
Catalpa speciosa	FACU	FAC	FACU	3	FACU	Bignoniaceae
Caulophyllum thalictroides	upl	upl	upl	5	UPL	Berberidaceae
Cayaponia quinqueloba	FAC	FAC	fac	0	FAC	Cucurbitaceae
Ceanothus americanus	upl	upl	upl	5	UPL	Rhamnaceae
Ceanothus herbaceus	upl	upl	upl	5	UPL	Rhamnaceae
CELASTRUS ORBICULATUS	FACU	FACU	UPL	5	UPL	Celastraceae
Celastrus scandens	FACU	FACU	FACU	3	FACU	Celastraceae
CELOSIA ARGENTEA	FAC	FACU	UPL	3	FACU	Amaranthaceae
Celtis laevigata	FACW	FACW	FACW	-3	FACW	Ulmaceae
Celtis occidentalis	FACU	FACU	FAC	3	FACU	Ulmaceae
Celtis pumila	upl	upl	upl	5	UPL	Ulmaceae
CENCHRUS CILIARIS	upl	upl	upl	5	UPL	Poaceae
Cenchrus longispinus	FACU	UPL	UPL	5	UPL	Poaceae
Cenchrus spinifex	UPL	UPL	UPL	5	UPL	Poaceae
Centaurea americana	upl	upl	upl	5	UPL	Asteraceae
CENTAUREA CYANUS	FACU	FACU	FACU	3	FACU	Asteraceae
CENTAUREA DIFFUSA	upl	upl	upl	5	UPL	Asteraceae
CENTAUREA DILUTA	upl	upl	upl	5	UPL	Asteraceae
CENTAUREA MELITENSIS	upl	upl	upl	5	UPL	Asteraceae
CENTAUREA NIGRA	upl	upl	upl	5	UPL	Asteraceae
CENTAUREA NIGRESCENS	upl	upl	upl	5	UPL	Asteraceae
CENTAUREA REPENS	upl	upl	upl	5	UPL	Asteraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
CENTAUREA SOLSTITIALIS	upl	upl	upl	5	UPL	Asteraceae
CENTAUREA STOEBE subsp. MICRANTHOS	upl	upl	upl	5	UPL	Asteraceae
Centrosema virginianum	UPL	UPL	upl	5	UPL	Fabaceae
Cephalanthus occidentalis	OBL	OBL	OBL	-5	OBL	Rubiaceae
Cerastium arvense subsp. strictum	FACU	UPL	FACU	3	FACU	Caryophyllaceae
CERASTIUM BRACHYPETALUM	upl	upl	upl	5	UPL	Caryophyllaceae
Cerastium brachypodum	FACU	FACU	FACU	3	FACU	Caryophyllaceae
CERASTIUM DIFFUSUM	upl	upl	upl	5	UPL	Caryophyllaceae
CERASTIUM DUBIUM	upl	upl	upl	5	UPL	Caryophyllaceae
CERASTIUM FONTANUM subsp. VULGARE	FAC	FACU	FACU	3	FACU	Caryophyllaceae
CERASTIUM GLOMERATUM	FACU	UPL	FACU	5	UPL	Caryophyllaceae
Cerastium nutans	FACU	FAC	FACU	3	FACU	Caryophyllaceae
CERASTIUM PUMILUM	upl	upl	upl	5	UPL	Caryophyllaceae
CERASTIUM SEMIDECANDRUM	upl	upl	upl	5	UPL	Caryophyllaceae
Cerastium velutinum	FACU	UPL	FACU	3	FACU	Caryophyllaceae
CERATOCEPHALUS TESTICULATUS	upl	upl	upl	5	UPL	Ranunculaceae
Ceratophyllum demersum	OBL	OBL	OBL	-5	OBL	Ceratophyllaceae
Ceratophyllum echinatum	OBL	OBL	OBL	-5	OBL	Ceratophyllaceae
CERATOSTIGMA PLUMBAGINOIDES	upl	upl	upl	5	UPL	Plumbaginaceae
Cercis canadensis	UPL	FACU	FACU	3	FACU	Fabaceae
CHAENOMELES SPECIOSA	upl	upl	upl	5	UPL	Rosaceae
CHAENORRHINUM MINUS	upl	upl	upl	5	UPL	Plantaginaceae
Chaerophyllum procumbens	FACW	FACW	FACW	-3	FACW	Apiaceae
Chaerophyllum tainturieri	FAC	FACW	FACU	0	FAC	Apiaceae
Chaetopappa asteroides	upl	upl	upl	5	UPL	Asteraceae
Chamaecrista fasciculata	FACU	FACU	FACU	3	FACU	Fabaceae
Chamaecrista nictitans	FACU	FACU	FACU	3	FACU	Fabaceae
Chasmanthium latifolium	FAC	FACU	FACW	0	FAC	Poaceae
Chasmanthium laxum	FACW	FAC	FACW	-3	FACW	Poaceae
Chasmanthium sessilifolium	FAC	FAC	FAC	0	FAC	Poaceae
Cheilanthes alabamensis	upl	upl	upl	5	UPL	Pteridaceae
Cheilanthes feei	upl	upl	upl	5	UPL	Pteridaceae
Cheilanthes lanosa	upl	upl	upl	5	UPL	Pteridaceae
Cheilanthes tomentosa	upl	upl	upl	5	UPL	Pteridaceae
CHELIDONIUM MAJUS	UPL	UPL	UPL	5	UPL	Papaveraceae
Chelone glabra	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Chelone obliqua	OBL	OBL	OBL	-5	OBL	Plantaginaceae
CHENOPODIUM ALBUM	FACU	FACU	FACU	3	FACU	Chenopodiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
CHENOPODIUM AMBROSIOIDES	upl	upl	upl	5	UPL	Chenopodiaceae
Chenopodium berlandieri	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM BOTRYS	upl	upl	upl	5	UPL	Chenopodiaceae
Chenopodium bushianum	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM CAPITATUM	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM DESICCATUM	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM FICIFOLIUM	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM GLAUCUM	FAC	FACW	FACW	0	FAC	Chenopodiaceae
CHENOPODIUM INCANUM	upl	upl	upl	5	UPL	Chenopodiaceae
Chenopodium missouriense	FACU	FACU	FACU	3	FACU	Chenopodiaceae
CHENOPODIUM MURALE	FACU	FACU	FACU	3	FACU	Chenopodiaceae
CHENOPODIUM OPULIFOLIUM	upl	upl	upl	5	UPL	Chenopodiaceae
Chenopodium pallescens	upl	upl	upl	5	UPL	Chenopodiaceae
Chenopodium pratericola	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM PUMILIO	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM RUBRUM	FACW	FACW	OBL	-3	FACW	Chenopodiaceae
Chenopodium simplex	upl	upl	upl	5	UPL	Chenopodiaceae
Chenopodium standleyanum	upl	upl	upl	5	UPL	Chenopodiaceae
Chenopodium strictum var. glaucophyllum	FACU	FACU	FACU	3	FACU	Chenopodiaceae
CHENOPODIUM URBICUM	upl	upl	upl	5	UPL	Chenopodiaceae
CHENOPODIUM WATSONII	upl	upl	upl	5	UPL	Chenopodiaceae
Chionanthus virginicus	FACU	FAC	FAC	3	FACU	Oleaceae
Chloris verticillata	upl	upl	upl	5	UPL	Poaceae
CHLORIS VIRGATA	FACU	FACU	FACU	3	FACU	Poaceae
CHORISPORA TENELLA	upl	upl	upl	5	UPL	Brassicaceae
CICHORIUM INTYBUS	FACU	FACU	FACU	3	FACU	Asteraceae
Cicuta maculata	OBL	OBL	OBL	-5	OBL	Apiaceae
Cinna arundinacea	FACW	FACW	FACW	-3	FACW	Poaceae
Circaea canadensis	FACU	FACU	FACU	3	FACU	Onagraceae
Cirsium altissimum	upl	upl	upl	5	UPL	Asteraceae
CIRSIUM ARVENSE	FACU	FACU	FACU	3	FACU	Asteraceae
CIRSIUM CANESCENS	upl	upl	upl	5	UPL	Asteraceae
Cirsium carolinianum	upl	upl	upl	5	UPL	Asteraceae
Cirsium discolor	UPL	UPL	FACU	5	UPL	Asteraceae
Cirsium muticum	OBL	OBL	OBL	-5	OBL	Asteraceae
CIRSIUM TEXANUM	upl	upl	upl	5	UPL	Asteraceae
Cirsium undulatum	FACU	FAC	FACU	3	FACU	Asteraceae
CIRSIUM VULGARE	FACU	FACU	FACU	3	FACU	Asteraceae
Cissus trifoliata	UPL	UPL	FAC	5	UPL	Vitaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
CITRULLUS LANATUS	UPL	UPL	FACU	3	FACU	Cucurbitaceae
CITRUS TRIFOLIATA	upl	upl	upl	5	UPL	Rutaceae
CLADIUM MARISCUS subsp. JAMAICENSE	OBL	obl	obl	-5	OBL	Cyperaceae
Cladrastis kentukea	upl	upl	upl	5	UPL	Fabaceae
CLAYTONIA PERFOLIATA	FACU	FACU	upl	3	FACU	Portulacaceae
Claytonia virginica	FACU	FAC	FACU	3	FACU	Portulacaceae
Clematis catesbyana	FAC	FAC	FAC	0	FAC	Ranunculaceae
Clematis crispa	FACW	FACW	OBL	-3	FACW	Ranunculaceae
Clematis fremontii	upl	upl	upl	5	UPL	Ranunculaceae
Clematis pitcheri	FACU	FACU	FACU	3	FACU	Ranunculaceae
CLEMATIS TERNIFLORA	FACU	FACU	UPL	3	FACU	Ranunculaceae
Clematis versicolor	upl	upl	upl	5	UPL	Ranunculaceae
Clematis viorna	upl	upl	upl	5	UPL	Ranunculaceae
Clematis virginiana	FAC	FAC	FAC	0	FAC	Ranunculaceae
CLEOME HASSLERIANA	upl	upl	upl	5	UPL	Cleomaceae
Cleome serrulata	facu	FACU	FACU	3	FACU	Cleomaceae
CLINOPODIUM ACINOS	upl	upl	upl	5	UPL	Lamiaceae
Clinopodium arkansanum	FACW	FACU	FACW	0	FAC	Lamiaceae
Clitoria mariana	FACU	FACU	FACU	5	[UPL]	Fabaceae
Cocculus carolinus	FAC	FAC	FAC	0	FAC	Menispermaceae
Coeloglossum viride	FAC	FACU	FAC	0	FAC	Orchidaceae
Coelorachis cylindrica	FAC	FAC	FACU	3	FACU	Poaceae
Collinsia verna	FAC	FAC	FACU	3	FACU	Plantaginaceae
Collinsia violacea	upl	upl	upl	5	UPL	Plantaginaceae
Collinsonia canadensis	FAC	FAC	FAC	0	FAC	Lamiaceae
COLLOMIA LINEARIS	UPL	UPL	FACU	5	UPL	Polemoniaceae
Comandra umbellata	UPL	FACU	FACU	5	UPL	Santalaceae
COMMELINA CAROLINIANA	FAC	FAC	FACU	0	FAC	Commelinaceae
COMMELINA COMMUNIS	FAC	FAC	FACU	0	FAC	Commelinaceae
COMMELINA DIFFUSA	FACW	FACW	FACW	-3	FACW	Commelinaceae
Commelina erecta	FACU	FAC	FAC	3	FACU	Commelinaceae
Commelina virginica	FACW	FACW	FACW	-3	FACW	Commelinaceae
CONIUM MACULATUM	FACW	FACW	FACW	-3	FACW	Apiaceae
Conoclinium coelestinum	FAC	FAC	FACW	0	FAC	Asteraceae
CONRINGIA ORIENTALIS	upl	upl	upl	5	UPL	Brassicaceae
CONVALLARIA MAJALIS	upl	upl	upl	5	UPL	Liliaceae
CONVOLVULUS ARVENSIS	upl	upl	upl	5	UPL	Convolvulaceae
Conyza canadensis var. canadensis	FACU	FACU	FACU	3	FACU	Asteraceae
Conyza canadensis var. pusilla	FACU	FACU	FACU	3	FACU	Asteraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Conyza ramosissima	upl	upl	upl	5	UPL	Asteraceae
Corallorhiza odontorhiza	upl	upl	upl	5	UPL	Orchidaceae
Corallorhiza wisteriana	UPL	FAC	FACU	3	FACU	Orchidaceae
Coreopsis grandiflora	upl	upl	upl	5	UPL	Asteraceae
Coreopsis lanceolata	UPL	FACU	FACU	5	UPL	Asteraceae
Coreopsis palmata	upl	upl	upl	5	UPL	Asteraceae
Coreopsis pubescens	FAC	FACU	FACU	3	FACU	Asteraceae
Coreopsis tinctoria	FAC	FAC	FACU	0	FAC	Asteraceae
Coreopsis tripteris	FAC	FAC	FAC	0	FAC	Asteraceae
CORIANDRUM SATIVUM	upl	upl	upl	5	UPL	Apiaceae
Corispermum americanum	FACU	FACU	FACU	3	FACU	Chenopodiaceae
Corispermum pallassii	upl	upl	upl	5	UPL	Chenopodiaceae
Corispermum villosum	upl	upl	upl	5	UPL	Chenopodiaceae
Cornus alternifolia	FAC	FAC	FAC	0	FAC	Cornaceae
Cornus amomum subsp. obliqua	FACW	FACW	FACW	-3	FACW	Cornaceae
Cornus drummondii	FAC	FAC	FAC	0	FAC	Cornaceae
Cornus florida	FACU	FACU	FACU	3	FACU	Cornaceae
Cornus foemina subsp. foemina	FACW	FACW	FACW	-3	FACW	Cornaceae
Cornus foemina subsp. racemosa	FAC	FAC	FAC	0	FAC	Cornaceae
Corydalis aurea subsp. aurea	upl	upl	upl	5	UPL	Fumariaceae
Corydalis aurea subsp. occidentalis	upl	upl	upl	5	UPL	Fumariaceae
Corydalis crystallina	upl	upl	upl	5	UPL	Fumariaceae
Corydalis flavula	FACU	FACU	FACU	3	FACU	Fumariaceae
Corydalis micrantha subsp. australis	upl	upl	upl	5	UPL	Fumariaceae
Corydalis micrantha subsp. micrantha	upl	upl	upl	5	UPL	Fumariaceae
Corylus americana	FACU	FACU	FACU	3	FACU	Betulaceae
COSMOS BIPINNATUS	FAC	FACU	FAC	3	FACU	Asteraceae
COSMOS PARVIFLORUS	FAC	FAC	FACU	3	FACU	Asteraceae
COSMOS SULPHUREUS	upl	FACU	FACU	5	UPL	Asteraceae
COTA TINCTORIA	upl	upl	upl	5	UPL	Asteraceae
Cotinus obovatus	upl	upl	upl	5	UPL	Anacardiaceae
COTONEASTER ACUTIFOLIUS	upl	upl	upl	5	UPL	Rosaceae
Crataegus berberifolia	upl	upl	FAC	5	UPL	Rosaceae
Crataegus biltmoreana	upl	upl	upl	5	UPL	Rosaceae
Crataegus calpodendron	upl	upl	upl	5	UPL	Rosaceae
Crataegus coccinioides	upl	upl	upl	5	UPL	Rosaceae
Crataegus collina	upl	upl	upl	5	UPL	Rosaceae
Crataegus crus-galli	FAC	FACU	FAC	3	FACU	Rosaceae
Crataegus fecunda	upl	upl	upl	5	UPL	Rosaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Crataegus gattingeri	upl	upl	upl	5	UPL	Rosaceae
Crataegus lanuginosa	upl	upl	upl	5	UPL	Rosaceae
Crataegus macracantha	upl	upl	upl	5	UPL	Rosaceae
Crataegus margarettae	upl	upl	upl	5	UPL	Rosaceae
Crataegus marshallii	FAC	FAC	FACW	-3	FACW	Rosaceae
Crataegus mollis	FAC	FACU	FAC	3	FACU	Rosaceae
Crataegus neobushii	upl	upl	upl	5	UPL	Rosaceae
Crataegus padifolia	upl	upl	upl	5	UPL	Rosaceae
Crataegus phaenopyrum	FAC	FAC	FAC	0	FAC	Rosaceae
Crataegus pruinosa	upl	upl	upl	5	UPL	Rosaceae
Crataegus reverchonii	upl	upl	upl	5	UPL	Rosaceae
Crataegus rubella	upl	upl	upl	5	UPL	Rosaceae
Crataegus schuettei	upl	upl	upl	5	UPL	Rosaceae
Crataegus sicca	upl	upl	upl	5	UPL	Rosaceae
Crataegus spathulata	FAC	FAC	FACW	0	FAC	Rosaceae
Crataegus succulenta	upl	upl	upl	5	UPL	Rosaceae
Crataegus texana	upl	upl	upl	5	UPL	Rosaceae
Crataegus uniflora	upl	upl	upl	5	UPL	Rosaceae
Crataegus viridis	FACW	FACW	FACW	-3	FACW	Rosaceae
CREPIS CAPILLARIS	UPL	UPL	FACU	5	UPL	Asteraceae
CREPIS PULCHRA	upl	upl	upl	5	UPL	Asteraceae
CREPIS SETOSA	upl	upl	upl	5	UPL	Asteraceae
CREPIS TECTORUM	upl	upl	upl	5	UPL	Asteraceae
Crotalaria sagittalis	upl	upl	upl	5	UPL	Fabaceae
CROTALARIA SPECTABILIS	FACU	FACU	FACU	3	FACU	Fabaceae
Croton capitatus var. capitatus	upl	upl	upl	5	UPL	Euphorbiaceae
Croton capitatus var. lindheimeri	upl	upl	upl	5	UPL	Euphorbiaceae
Croton glandulosus var. septentrionalis	upl	upl	upl	5	UPL	Euphorbiaceae
CROTON LINDHEIMERIANUS	upl	upl	upl	5	UPL	Euphorbiaceae
Croton michauxii	upl	upl	upl	5	UPL	Euphorbiaceae
Croton monanthogynus	upl	upl	upl	5	UPL	Euphorbiaceae
CROTON TEXENSIS	upl	upl	upl	5	UPL	Euphorbiaceae
Croton wildenowii	upl	upl	upl	5	UPL	Euphorbiaceae
CRYPSIS SCHOENOIDES	FACU	FACU	FACU	3	FACU	Poaceae
Cryptotaenia canadensis	FAC	FAC	FAC	0	FAC	Apiaceae
Cubelium concolor	FACU	FACU	FACU	3	FACU	Violaceae
CUCUMIS MELO	upl	upl	upl	5	UPL	Cucurbitaceae
CUCUMIS SATIVUS	upl	upl	upl	5	UPL	Cucurbitaceae
CUCURBITA FOETIDISSIMA	upl	upl	upl	5	UPL	Cucurbitaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
CUCURBITA PEPO var. OVIFERA	upl	upl	upl	5	UPL	Cucurbitaceae
Cucurbita pepo var. ozarkana	upl	upl	upl	5	UPL	Cucurbitaceae
Cunila origanoides	upl	upl	upl	5	UPL	Lamiaceae
Cuphea viscosissima	FAC	FAC	FACU	0	FAC	Lythraceae
Cuscuta campestris	upl	upl	upl	5	UPL	Convolvulaceae
Cuscuta cephalanthi	upl	upl	upl	5	UPL	Convolvulaceae
Cuscuta compacta	upl	upl	upl	5	UPL	Convolvulaceae
Cuscuta coryli	upl	upl	upl	5	UPL	Convolvulaceae
Cuscuta cuspidata	facw	facw	facw	-3	[FACW]	Convolvulaceae
Cuscuta glomerata	fac	fac	fac	0	[FAC]	Convolvulaceae
Cuscuta gronovii	fac	fac	fac	0	[FAC]	Convolvulaceae
Cuscuta indecora	fac	fac	fac	0	[FAC]	Convolvulaceae
Cuscuta obtusiflora var. glandulosa	upl	upl	upl	5	UPL	Convolvulaceae
Cuscuta pentagona	upl	upl	upl	5	UPL	Convolvulaceae
Cuscuta polygonorum	facw	facw	facw	-3	[FACW]	Convolvulaceae
Cyclachaena xanthifolia	FAC	FAC	FAC	0	FAC	Asteraceae
Cycloloma atriplicifolium	FACU	FACU	FACU	3	FACU	Chenopodiaceae
CYLINDROPUNTIA IMBRICATA	upl	upl	upl	5	UPL	Cactaceae
CYMBALARIA MURALIS	upl	upl	upl	5	UPL	Plantaginaceae
Cynanchum laeve	FAC	FAC	FAC	0	FAC	Asclepiadaceae
CYNANCHUM LOUISEAE	upl	upl	upl	5	UPL	Asclepiadaceae
CYNODON DACTYLON	FACU	FACU	FACU	3	FACU	Poaceae
CYNOGLOSSUM CRETICUM	upl	upl	upl	5	UPL	Boraginaceae
CYNOGLOSSUM OFFICINALE	UPL	UPL	FACU	5	UPL	Boraginaceae
Cynoglossum virginianum	upl	upl	upl	5	UPL	Boraginaceae
Cynosciadium digitatum	FACW	FACW	FACW	-3	FACW	Apiaceae
CYNOSURUS ECHINATUS	UPL	UPL	UPL	5	UPL	Poaceae
Cyperus acuminatus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Cyperus bipartitus	FACW	FACW	OBL	-3	FACW	Cyperaceae
Cyperus compressus	FACW	FAC	FACW	-3	FACW	Cyperaceae
Cyperus croceus	FAC	FACU	FAC	0	FAC	Cyperaceae
Cyperus diandrus	FACW	FACW	FACW	-3	FACW	Cyperaceae
CYPERUS DIFFORMIS	OBL	OBL	OBL	-5	OBL	Cyperaceae
Cyperus echinatus	FAC	FACU	FAC	0	FAC	Cyperaceae
Cyperus erythrorhizos	OBL	FACW	OBL	-3	FACW	Cyperaceae
Cyperus esculentus	FAC	FACW	FACW	-3	FACW	Cyperaceae
Cyperus flavescens var. poiformis	OBL	OBL	OBL	-5	OBL	Cyperaceae
CYPERUS FLAVICOMIS	FACW	FAC	FAC	0	FAC	Cyperaceae
CYPERUS FUSCUS	FAC	FAC	FAC	0	FAC	Cyperaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Cyperus grayoides	upl	upl	upl	5	UPL	Cyperaceae
Cyperus hystricinus	upl	upl	upl	5	UPL	Cyperaceae
CYPERUS IRIA	FACW	FACW	FACW	-3	FACW	Cyperaceae
Cyperus lancastriensis	FAC	FAC	FAC	0	FAC	Cyperaceae
Cyperus lupulinus subsp. lupulinus	FACU	UPL	FACU	3	FACU	Cyperaceae
Cyperus lupulinus subsp. macilentus	FACU	UPL	FACU	3	FACU	Cyperaceae
Cyperus odoratus	FACW	FACW	FACW	-3	FACW	Cyperaceae
Cyperus plukenettii	upl	upl	upl	5	UPL	Cyperaceae
Cyperus polystachyos var. texensis	FACW	FACW	FACW	-3	FACW	Cyperaceae
Cyperus pseudovegetus	FACW	FACW	FACW	-3	FACW	Cyperaceae
Cyperus refractus	FAC	FACU	FACU	3	FACU	Cyperaceae
Cyperus retroflexus	upl	upl	upl	5	UPL	Cyperaceae
Cyperus retrofractus	FAC	FACU	FACU	3	FACU	Cyperaceae
CYPERUS RETRORSUS	FACU	FAC	FAC	0	FAC	Cyperaceae
CYPERUS ROTUNDUS	FAC	FAC	FAC	0	FAC	Cyperaceae
Cyperus schweinitzii	UPL	FACU	FACU	3	FACU	Cyperaceae
Cyperus setigerus	FAC	FAC	FAC	0	FAC	Cyperaceae
Cyperus squarrosus	OBL	FACW	OBL	-5	OBL	Cyperaceae
Cyperus strigosus	FACW	FACW	FACW	-3	FACW	Cyperaceae
Cypripedium calceolus var. parviflorum	FAC	FACW	FACW	-3	FACW	Orchidaceae
Cypripedium calceolus var. pubescens	FAC	FACW	FACW	0	FAC	Orchidaceae
Cypripedium candidum	OBL	OBL	OBL	-5	OBL	Orchidaceae
Cypripedium reginae	facw	FACW	FACW	-3	FACW	Orchidaceae
Cystopteris bulbifera	FAC	FAC	FACW	0	FAC	Dryopteridaceae
Cystopteris protrusa	FAC	FAC	FACW	0	FAC	Dryopteridaceae
Cystopteris tennesseensis	upl	upl	upl	5	UPL	Dryopteridaceae
Cystopteris tenuis	upl	upl	upl	5	UPL	Dryopteridaceae
DACTYLIS GLOMERATA	FACU	FACU	FACU	3	FACU	Poaceae
Dalea candida	upl	upl	upl	5	UPL	Fabaceae
Dalea enneandra	upl	upl	upl	5	UPL	Fabaceae
Dalea gattingeri	upl	upl	upl	5	UPL	Fabaceae
Dalea leporina	UPL	UPL	FACU	5	UPL	Fabaceae
Dalea multiflora	upl	upl	upl	5	UPL	Fabaceae
Dalea purpurea	upl	upl	upl	5	UPL	Fabaceae
DALEA VILLOSA	upl	upl	upl	5	UPL	Fabaceae
Danthonia spicata	upl	upl	upl	5	UPL	Poaceae
Dasistoma macrophyllum	FAC	FACU	FACU	3	FACU	Orobanchaceae
DATURA INOXIA	UPL	FACU	FACU	5	UPL	Solanaceae
DATURA STRAMONIUM	upl	upl	upl	5	UPL	Solanaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
DATURA WRIGHTII	UPL	FACU	FACU	5	UPL	Solanaceae
DAUCUS CAROTA	UPL	UPL	UPL	5	UPL	Apiaceae
Daucus pusillus	upl	upl	upl	5	UPL	Apiaceae
Decodon verticillatus	OBL	OBL	OBL	-5	OBL	Lythraceae
DELPHINIUM AJACIS	upl	upl	upl	5	UPL	Ranunculaceae
Delphinium carolinianum subsp. carolinianum	upl	upl	upl	5	UPL	Ranunculaceae
Delphinium carolinianum subsp. virescens	upl	upl	upl	5	UPL	Ranunculaceae
DELPHINIUM CONSOLIDA	upl	upl	upl	5	UPL	Ranunculaceae
Delphinium exaltatum	upl	upl	upl	5	UPL	Ranunculaceae
Delphinium treleasei	upl	upl	upl	5	UPL	Ranunculaceae
Delphinium tricorne	upl	upl	upl	5	UPL	Ranunculaceae
Dennstaedtia punctilobula	UPL	FACU	UPL	5	UPL	Dennstaedtiaceae
Deparia acrostichoides	FAC	FAC	FAC	0	FAC	Dryopteridaceae
Descurainia pinnata subsp. brachycarpa	upl	upl	upl	5	UPL	Brassicaceae
Descurainia pinnata subsp. pinnata	upl	upl	upl	5	UPL	Brassicaceae
DESCURAINIA SOPHIA	upl	upl	upl	5	UPL	Brassicaceae
Desmanthus illinoensis	FAC	FAC	FACU	3	FACU	Fabaceae
DESMANTHUS LEPTOLOBUS	upl	upl	upl	5	UPL	Fabaceae
Desmodium × humifusum	upl	upl	upl	5	UPL	Fabaceae
Desmodium canadense	FAC	FAC	FACU	3	FACU	Fabaceae
Desmodium canescens	upl	upl	upl	5	UPL	Fabaceae
Desmodium ciliare	upl	upl	upl	5	UPL	Fabaceae
Desmodium cuspidatum	upl	upl	upl	5	UPL	Fabaceae
Desmodium glabellum	upl	upl	upl	5	UPL	Fabaceae
Desmodium illinoense	upl	upl	upl	5	UPL	Fabaceae
Desmodium laevigatum	upl	upl	upl	5	UPL	Fabaceae
Desmodium marilandicum	upl	upl	upl	5	UPL	Fabaceae
Desmodium nuttallii	upl	upl	upl	5	UPL	Fabaceae
Desmodium obtusum	upl	upl	upl	5	UPL	Fabaceae
Desmodium ochroleucum	upl	upl	upl	5	UPL	Fabaceae
Desmodium paniculatum	FACU	FACU	FACU	3	FACU	Fabaceae
Desmodium perplexum	upl	upl	upl	5	UPL	Fabaceae
Desmodium rotundifolium	upl	upl	upl	5	UPL	Fabaceae
Desmodium sessilifolium	upl	upl	upl	5	UPL	Fabaceae
Desmodium strictum	upl	upl	upl	5	UPL	Fabaceae
Desmodium viridiflorum	upl	upl	upl	5	UPL	Fabaceae
DIANTHUS ARMERIA	UPL	UPL	UPL	5	UPL	Caryophyllaceae
DIANTHUS BARBATUS	upl	upl	upl	5	UPL	Caryophyllaceae
DIANTHUS DELTOIDES	UPL	UPL	FACU	5	UPL	Caryophyllaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
DIANTHUS PLUMARIUS	upl	upl	upl	5	UPL	Caryophyllaceae
DIAPERIA PROLIFERA	upl	upl	upl	5	UPL	Asteraceae
Diarrhena americana	upl	upl	upl	3	[FACU]	Poaceae
Diarrhena obovata	FAC	FACU	FAC	3	FACU	Poaceae
Dicentra canadensis	upl	upl	upl	5	UPL	Fumariaceae
Dicentra cucullaria	upl	upl	upl	5	UPL	Fumariaceae
Dichanthelium angustifolium	FACU	FACU	FACU	3	FACU	Poaceae
Dichanthelium annulum	FAC	FAC	FAC	0	FAC	Poaceae
Dichanthelium ashei	FAC	FACU	FAC	3	FACU	Poaceae
Dichanthelium bicknellii	FACU	FACU	FAC	3	FACU	Poaceae
Dichanthelium boscii	upl	upl	upl	5	UPL	Poaceae
Dichanthelium clandestinum	FACW	FAC	FACW	-3	FACW	Poaceae
Dichanthelium columbianum	FACU	FACU	FACU	3	FACU	Poaceae
Dichanthelium commonsianum	FAC	FACU	FAC	3	FACU	Poaceae
Dichanthelium commutatum var. commutatum	FAC	FACU	FAC	3	FACU	Poaceae
Dichanthelium depauperatum	upl	upl	upl	5	UPL	Poaceae
Dichanthelium dichotomum var. barbulatum	FAC	FAC	FAC	5	[UPL]	Poaceae
Dichanthelium dichotomum var. dichotomum	FAC	FAC	FAC	5	[UPL]	Poaceae
Dichanthelium dichotomum var. yadkinense	FAC	FAC	FAC	0	FAC	Poaceae
Dichanthelium implicatum	FAC	FAC	FAC	0	FAC	Poaceae
Dichanthelium joorii	FAC	FACU	FAC	3	FACU	Poaceae
Dichanthelium lanuginosum	FAC	FAC	FAC	3	[FACU]	Poaceae
Dichanthelium latifolium	FACU	FACU	FACU	3	FACU	Poaceae
Dichanthelium laxiflorum	FAC	FACU	FACU	3	FACU	Poaceae
Dichanthelium leibergii	facu	FACU	FACU	3	FACU	Poaceae
Dichanthelium lindheimeri	FAC	FAC	FAC	0	FAC	Poaceae
Dichanthelium linearifolium var. linearifolium	upl	upl	upl	5	UPL	Poaceae
Dichanthelium longiligulatum	upl	upl	upl	5	UPL	Poaceae
Dichanthelium malacophyllum	upl	upl	upl	5	UPL	Poaceae
Dichanthelium microcarpon	FAC	FAC	FAC	0	FAC	Poaceae
Dichanthelium nitidum	FAC	FAC	FAC	0	FAC	Poaceae
Dichanthelium oligosanthes var. oligosanthes	FACU	FACU	FACU	3	FACU	Poaceae
Dichanthelium oligosanthes var. scribnerianum	FACU	FACU	FACU	3	FACU	Poaceae
Dichanthelium perlongum	upl	upl	upl	5	UPL	Poaceae
Dichanthelium polyanthes	FACU	FACU	FACU	3	FACU	Poaceae
Dichanthelium praecocius	upl	upl	upl	5	UPL	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Dichanthelium ravenelii	FACU	FACU	FAC	3	FACU	Poaceae
Dichanthelium scoparium	FACW	FACW	FACW	-3	FACW	Poaceae
Dichanthelium sphaerocarpon	FACU	FACU	FACU	3	FACU	Poaceae
Dichanthelium villosissimum	upl	upl	upl	5	UPL	Poaceae
Dichanthelium werneri	upl	upl	upl	5	UPL	Poaceae
DICHELOSTEMMA CONGESTUM	upl	upl	upl	5	UPL	Liliaceae
DICHONDRA CAROLINENSIS	FAC	FACW	FAC	0	FAC	Convolvulaceae
Dicliptera brachiata	FACW	FACW	FACW	-3	FACW	Acanthaceae
DICTAMNUS ALBUS	upl	upl	upl	5	UPL	Rutaceae
Didiplis diandra	OBL	OBL	OBL	-5	OBL	Lythraceae
DIGITARIA CILIARIS	FACU	FAC	FACU	3	FACU	Poaceae
Digitaria cognata	upl	upl	upl	5	UPL	Poaceae
Digitaria filiformis	upl	upl	upl	5	UPL	Poaceae
DIGITARIA ISCHAEMUM	UPL	UPL	FACU	3	FACU	Poaceae
DIGITARIA SANGUINALIS	FACU	FACU	FACU	3	FACU	Poaceae
DIGITARIA VIOLASCENS	upl	upl	FAC	5	UPL	Poaceae
Diodia teres	FACU	UPL	FACU	5	UPL	Rubiaceae
Diodia virginiana	FACW	FACW	FACW	-3	FACW	Rubiaceae
DIOSCOREA OPPOSITIFOLIA	upl	upl	upl	5	UPL	Dioscoreaceae
Dioscorea quaternata	upl	upl	upl	5	UPL	Dioscoreaceae
Dioscorea villosa	FACW	FAC	FAC	0	FAC	Dioscoreaceae
Diospyros virginiana	FAC	FAC	FAC	0	FAC	Ebenaceae
Diplazium pycnocarpon	FAC	FAC	FACU	0	FAC	Dryopteridaceae
DIPLOTAXIS MURALIS	upl	upl	upl	5	UPL	Brassicaceae
DIPSACUS FULLONUM	FACU	FACU	FACU	3	FACU	Dipsacaceae
DIPSACUS LACINIATUS	FACU	FACU	UPL	3	FACU	Dipsacaceae
Dirca palustris	FACU	FAC	FAC	0	FAC	Thymelaeaceae
Distichlis spicata var. spicata	OBL	FACW	FACW	-3	FACW	Poaceae
DISTICHLIS SPICATA var. STRICTA	OBL	FACW	FACW	3	[FACU]	Poaceae
Doellingeria umbellata var. pubens	FACW	FACW	FACW	-3	FACW	Asteraceae
Draba aprica	upl	upl	upl	5	UPL	Brassicaceae
Draba brachycarpa	upl	upl	upl	5	UPL	Brassicaceae
Draba cuneifolia	upl	upl	upl	5	UPL	Brassicaceae
Draba reptans	upl	upl	upl	5	UPL	Brassicaceae
DRABA VERNA	upl	upl	upl	5	UPL	Brassicaceae
DRACOCEPHALUM PARVIFLORUM	FACU	FACU	FACU	3	FACU	Lamiaceae
Drymocallis arguta	upl	upl	upl	5	UPL	Rosaceae
Dryopteris carthusiana	FACW	FAC	FACW	-3	FACW	Dryopteridaceae
Dryopteris celsa	FAC	OBL	OBL	-3	FACW	Dryopteridaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Dryopteris cristata	OBL	FACW	OBL	-5	OBL	Dryopteridaceae
Dryopteris goldiana	FAC	FAC	FAC	0	FAC	Dryopteridaceae
Dryopteris intermedia	FACU	FACU	FAC	3	FACU	Dryopteridaceae
Dryopteris marginalis	FACU	FACU	FACU	3	FACU	Dryopteridaceae
DUCHESNEA INDICA	FACU	FACU	FACU	3	FACU	Rosaceae
Dulichium arundinaceum	OBL	OBL	OBL	-5	OBL	Cyperaceae
Dyssodia papposa	upl	upl	upl	5	UPL	Asteraceae
Echinacea angustifolia	upl	upl	upl	5	UPL	Asteraceae
Echinacea pallida	upl	upl	upl	5	UPL	Asteraceae
Echinacea paradoxa	upl	upl	upl	5	UPL	Asteraceae
Echinacea purpurea	upl	upl	upl	5	UPL	Asteraceae
Echinacea simulata	upl	upl	upl	5	UPL	Asteraceae
ECHINOCHLOA COLONUM	FACW	FACW	FACW	-3	FACW	Poaceae
ECHINOCHLOA CRUSGALLI	FACW	FAC	FACW	0	FAC	Poaceae
ECHINOCHLOA CRUS-PAVONIS var. MACERA	OBL	FACW	FACW	-5	OBL	Poaceae
Echinochloa muricata	FACW	FACW	OBL	-5	OBL	Poaceae
Echinochloa walteri	OBL	FACW	OBL	-5	OBL	Poaceae
Echinocystis lobata	FACW	FAC	FACW	0	FAC	Cucurbitaceae
Echinodorus berteroi	OBL	OBL	OBL	-5	OBL	Alismataceae
Echinodorus cordifolius	OBL	OBL	OBL	-5	OBL	Alismataceae
Echinodorus tenellus	OBL	OBL	OBL	-5	OBL	Alismataceae
ECHIUM VULGARE	upl	upl	upl	5	UPL	Boraginaceae
Eclipta prostrata	FACW	FAC	FACW	-3	FACW	Asteraceae
EGERIA DENSA	OBL	OBL	OBL	-5	OBL	Hydrocharitaceae
EICHHORNIA CRASSIPES	OBL	OBL	OBL	-5	OBL	Pontederiaceae
ELAEAGNUS ANGUSTIFOLIA	FACU	FACU	FACU	3	FACU	Elaeagnaceae
ELAEAGNUS UMBELLATA	upl	upl	upl	5	UPL	Elaeagnaceae
Elatine triandra	obl	obl	obl	-5	OBL	Elatinaceae
Eleocharis acicularis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis atropurpurea	FACW	FACW	FACW	-3	FACW	Cyperaceae
Eleocharis compressa var. acutisquamata	FACW	OBL	FACW	-3	FACW	Cyperaceae
Eleocharis compressa var. compressa	FACW	OBL	FACW	-3	FACW	Cyperaceae
Eleocharis elliptica	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis engelmannii	FACW	FACW	FACW	-3	FACW	Cyperaceae
Eleocharis equisetoides	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis erythropoda	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis lanceolata	FACW	FACW	FACW	-3	FACW	Cyperaceae
Eleocharis macrostachya	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis obtusa	OBL	OBL	OBL	-5	OBL	Cyperaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Eleocharis ovata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis palustris	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis parvula	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis quadrangulata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis tenuis var. atrata	FACW	FACW	FACW	-3	FACW	Cyperaceae
Eleocharis verrucosa	FACW	FACW	FACW	-3	FACW	Cyperaceae
Eleocharis wolfii	OBL	OBL	OBL	-5	OBL	Cyperaceae
Eleocharis xyridiformis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Elephantopus carolinianus	FACU	FACU	FAC	3	FACU	Asteraceae
ELEUSINE INDICA	FACU	FACU	FACU	3	FACU	Poaceae
ELEUSINE TRISTACHYA	upl	upl	upl	5	UPL	Poaceae
Ellisia nyctelea	FAC	FACU	FAC	3	FACU	Hydrophyllaceae
Elodea canadensis	OBL	OBL	OBL	-5	OBL	Hydrocharitaceae
Elodea nuttallii	OBL	OBL	OBL	-5	OBL	Hydrocharitaceae
Elymus canadensis	FAC	FACU	FACU	3	FACU	Poaceae
Elymus churchii	upl	upl	upl	5	UPL	Poaceae
Elymus curvatus	FAC	FACW	FACW	0	FAC	Poaceae
ELYMUS ELONGATUS subsp. PONTICUS	upl	upl	upl	5	UPL	Poaceae
Elymus glabriflorus	FAC	FACW	FACW	0	FAC	Poaceae
Elymus glaucus	facu	FACU	FACU	3	FACU	Poaceae
Elymus hystrix	UPL	UPL	FACU	3	FACU	Poaceae
Elymus jejunus	FAC	FACW	FACW	0	FAC	Poaceae
ELYMUS LONGIFOLIUS	facu	FACU	FACU	3	FACU	Poaceae
Elymus macgregorii	FAC	FACW	FACW	0	FAC	Poaceae
ELYMUS REPENS	FACU	FACU	FACU	3	FACU	Poaceae
Elymus riparius	FACW	FACW	FACW	-3	FACW	Poaceae
ELYMUS TRACHYCAULUS	FAC	FACU	FACU	3	FACU	Poaceae
Elymus villosus	FACU	FACU	FACU	3	FACU	Poaceae
Elymus virginicus	FAC	FACW	FACW	0	FAC	Poaceae
ENGELMANNIA PERISTENIA	upl	upl	upl	5	UPL	Asteraceae
Epifagus virginiana	upl	upl	upl	5	UPL	Orobanchaceae
EPILOBIUM CILIATUM	FACW	FAC	FACW	0	FAC	Onagraceae
Epilobium coloratum	OBL	FACW	OBL	-5	OBL	Onagraceae
Epilobium leptophyllum	OBL	OBL	OBL	-5	OBL	Onagraceae
EPIPACTIS HELLEBORINE	UPL	UPL	FACU	5	UPL	Orchidaceae
Equisetum × ferrissii	FACW	FACW	FACW	-3	FACW	Equisetaceae
Equisetum × nelsonii	obl	FAC	FAC	-5	[OBL]	Equisetaceae
Equisetum arvense	FAC	FAC	FAC	0	FAC	Equisetaceae
Equisetum hyemale	FACW	FACW	FACW	-3	FACW	Equisetaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Equisetum laevigatum	FAC	FACW	FACW	-3	FACW	Equisetaceae
ERAGROSTIS BARRELIERI	upl	upl	upl	5	UPL	Poaceae
Eragrostis capillaris	upl	upl	upl	5	UPL	Poaceae
ERAGROSTIS CILIANENSIS	FACU	FACU	FACU	3	FACU	Poaceae
ERAGROSTIS CURTIPEDICELLATA	upl	upl	upl	5	UPL	Poaceae
ERAGROSTIS CURVULA	upl	upl	upl	5	UPL	Poaceae
ERAGROSTIS ELLIOTTII	FACW	FACW	FACW	-3	FACW	Poaceae
Eragrostis frankii	FACW	FACW	FACW	-3	FACW	Poaceae
Eragrostis glomerata	upl	upl	upl	5	UPL	Poaceae
Eragrostis hirsuta	FACU	UPL	FACU	3	FACU	Poaceae
Eragrostis hypnoides	OBL	OBL	OBL	-5	OBL	Poaceae
Eragrostis intermedia	upl	upl	upl	5	UPL	Poaceae
ERAGROSTIS MINOR	upl	upl	upl	5	UPL	Poaceae
ERAGROSTIS PECTINACEA var. MISERRIMA	FAC	FAC	FAC	0	FAC	Poaceae
Eragrostis pectinacea var. pectinacea	FAC	FAC	FAC	0	FAC	Poaceae
ERAGROSTIS PILOSA	FACU	FACU	FACU	3	FACU	Poaceae
Eragrostis reptans	FAC	FACW	OBL	-3	FACW	Poaceae
ERAGROSTIS SECUNDIFLORA subsp. OXYLEPIS	UPL	UPL	FACU	5	UPL	Poaceae
Eragrostis spectabilis	FACU	UPL	UPL	5	UPL	Poaceae
Eragrostis trichodes	upl	upl	upl	5	UPL	Poaceae
ERANTHUS HYEMALIS	upl	upl	upl	5	UPL	Ranunculaceae
Erechtites hieracifolius	upl	upl	upl	5	UPL	Asteraceae
Erianthus alopecuroides	FAC	FAC	FACU	3	FACU	Poaceae
ERIANTHUS GIGANTEUS	FACW	FACW	FACW	-3	FACW	Poaceae
ERIANTHUS RAVENNAE	FAC	UPL	FACW	3	FACU	Poaceae
Erianthus strictus	OBL	OBL	OBL	-5	OBL	Poaceae
Erigenia bulbosa	upl	upl	upl	5	UPL	Apiaceae
Erigeron annuus	FACU	FACU	FACU	3	FACU	Asteraceae
Erigeron philadelphicus	FAC	FACU	FACW	0	FAC	Asteraceae
Erigeron pulchellus	FACU	FACU	FACU	3	FACU	Asteraceae
Erigeron strigosus	FAC	FACU	FACU	3	FACU	Asteraceae
Erigeron tenuis	upl	upl	upl	5	UPL	Asteraceae
ERIOCHLOA ACUMINATA	FAC	FAC	FACW	0	FAC	Poaceae
ERIOCHLOA CONTRACTA	FAC	FACU	FAC	3	FACU	Poaceae
ERIOCHLOA VILLOSA	upl	upl	upl	5	UPL	Poaceae
ERIOGONUM ANNUUM	upl	upl	upl	5	UPL	Polygonaceae
Eriogonum longifolium	upl	upl	upl	5	UPL	Polygonaceae
ERODIUM CICUTARIUM	upl	upl	upl	5	UPL	Geraniaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
ERODIUM TEXANUM	upl	upl	upl	5	UPL	Geraniaceae
ERUCA VESICARIA subsp. SATIVA	upl	upl	upl	5	UPL	Brassicaceae
ERUCASTRUM GALLICUM	upl	upl	upl	5	UPL	Brassicaceae
ERYNGIUM LEAVENWORTHII	upl	upl	upl	5	UPL	Apiaceae
Eryngium prostratum	FACW	OBL	OBL	-5	OBL	Apiaceae
Eryngium yuccifolium	FAC	FAC	FAC	0	FAC	Apiaceae
Erysimum capitatum	upl	upl	upl	5	UPL	Brassicaceae
ERYSIMUM CHEIRANTHOIDES	UPL	FAC	FACU	3	FACU	Brassicaceae
ERYSIMUM INCONSPICUUM	upl	upl	upl	5	UPL	Brassicaceae
ERYSIMUM REPANDUM	upl	upl	upl	5	UPL	Brassicaceae
Erythronium albidum	UPL	FACU	FACU	3	FACU	Liliaceae
Erythronium americanum	UPL	UPL	UPL	5	UPL	Liliaceae
Erythronium mesochoreum	UPL	UPL	UPL	5	UPL	Liliaceae
Erythronium rostratum	FACU	UPL	FACU	3	FACU	Liliaceae
ESCHSCHOLTZIA CALIFORNICA	upl	upl	upl	5	UPL	Papaveraceae
EUONYMUS ALATUS	upl	upl	upl	5	UPL	Celastraceae
Euonymus americanus	FAC	FAC	FAC	0	FAC	Celastraceae
Euonymus atropurpureus	FAC	FACU	FAC	3	FACU	Celastraceae
EUONYMUS EUROPAEUS	upl	upl	upl	5	UPL	Celastraceae
EUONYMUS HEDERACEUS	upl	upl	upl	5	UPL	Celastraceae
Euonymus obovatus	FACU	FAC	FAC	0	FAC	Celastraceae
Eupatorium album	upl	upl	upl	5	UPL	Asteraceae
Eupatorium altissimum	upl	upl	upl	5	UPL	Asteraceae
EUPATORIUM CAPILLIFOLIUM	FACU	FACU	FACU	3	FACU	Asteraceae
Eupatorium fistulosum	FACW	FACW	OBL	-5	OBL	Asteraceae
Eupatorium hyssopifolium var. calcaratum	upl	upl	upl	5	UPL	Asteraceae
Eupatorium maculatum	FACW	FACW	OBL	-5	OBL	Asteraceae
Eupatorium perfoliatum	FACW	FACW	OBL	-3	FACW	Asteraceae
Eupatorium purpureum	FAC	FAC	FAC	0	FAC	Asteraceae
Eupatorium rotundifolium	FAC	FAC	FAC	0	FAC	Asteraceae
Eupatorium semiserratum	FACW	FACW	FACW	-3	FACW	Asteraceae
Eupatorium serotinum	FAC	FAC	FAC	0	FAC	Asteraceae
Eupatorium sessilifolium	upl	upl	upl	5	UPL	Asteraceae
Eupatorium torreyanum	upl	upl	upl	5	UPL	Asteraceae
Euphorbia commutata	FACU	FACU	UPL	3	FACU	Euphorbiaceae
Euphorbia corollata	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia cyathophora	FACU	UPL	FACU	3	FACU	Euphorbiaceae
EUPHORBIA CYPARISSIAS	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia davidii	upl	upl	upl	5	UPL	Euphorbiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Euphorbia dentata	upl	upl	upl	5	UPL	Euphorbiaceae
EUPHORBIA ESULA	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia geyeri	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia glyptosperma	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia humistrata	FACW	FAC	FACW	0	FAC	Euphorbiaceae
Euphorbia maculata	FACU	FACU	FACU	3	FACU	Euphorbiaceae
Euphorbia marginata	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia missurica	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia nutans	FACU	FACU	FACU	3	FACU	Euphorbiaceae
Euphorbia obtusata	FACU	FACU	FACU	3	FACU	Euphorbiaceae
EUPHORBIA OPTHALMICA	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia ouachitana	upl	upl	upl	5	UPL	Euphorbiaceae
EUPHORBIA PROSTRATA	FACU	FACU	FACU	3	FACU	Euphorbiaceae
Euphorbia serpens	FAC	FACW	FACW	0	FAC	Euphorbiaceae
EUPHORBIA SERPYLLIFOLIA	upl	upl	upl	5	UPL	Euphorbiaceae
Euphorbia spathulata	FACU	FACU	FACU	3	FACU	Euphorbiaceae
EUPHORBIA STICTOSPORA	upl	upl	upl	5	UPL	Euphorbiaceae
Eurybia furcata	upl	upl	upl	5	UPL	Asteraceae
Eurybia hemispherica	FACU	FACU	FACU	3	FACU	Asteraceae
Eurybia macrophylla	UPL	UPL	FACU	5	UPL	Asteraceae
Euthamia graminifolia	FAC	FAC	FACW	0	FAC	Asteraceae
Euthamia gymnospermoides	FAC	FAC	FACW	3	[FACU]	Asteraceae
Euthamia leptocephala	FACW	FACW	FACW	-3	FACW	Asteraceae
EVOLVULUS ALSINOIDES	UPL	UPL	UPL	5	UPL	Convolvulaceae
Evolvulus nuttallianus	upl	upl	upl	5	UPL	Convolvulaceae
EXOCHORDA RACEMOSA	upl	upl	upl	5	UPL	Rosaceae
FAGOPYRUM ESCULENTUM	upl	upl	upl	5	UPL	Polygonaceae
Fagus grandifolia	FACU	FACU	FACU	3	FACU	Fagaceae
FALCARIA VULGARIS	upl	upl	upl	5	UPL	Apiaceae
FALLOPIA CONVOLVULUS	FACU	FACU	FACU	3	FACU	Polygonaceae
FALLOPIA DUMETORUM	FACU	FACU	FAC	3	FACU	Polygonaceae
FALLOPIA JAPONICA	UPL	FACU	FACU	3	FACU	Polygonaceae
Fallopia scandens	FAC	FAC	FAC	0	FAC	Polygonaceae
FATOUA VILLOSA	FACU	FAC	FAC	0	FAC	Moraceae
FESTUCA ARUNDINACEA	FAC	FACU	FACU	0	FAC	Poaceae
FESTUCA OVINA	UPL	UPL	FACU	5	UPL	Poaceae
Festuca paradoxa	FAC	FAC	FAC	0	FAC	Poaceae
FESTUCA PRATENSIS	FACU	FACU	FACU	3	FACU	Poaceae
FESTUCA RUBRA	FACU	FACU	FACU	3	FACU	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
FESTUCA SORORIA	upl	upl	upl	5	UPL	Poaceae
Festuca subverticillata	FACU	FACU	FACU	3	FACU	Poaceae
FESTUCA TRACHYPHYLLA	UPL	UPL	FACU	5	UPL	Poaceae
Filipendula rubra	OBL	FACU	OBL	-5	OBL	Rosaceae
Fimbristylis annua	FACW	FACW	FACW	-3	FACW	Cyperaceae
Fimbristylis autumnalis	OBL	FACW	OBL	-3	FACW	Cyperaceae
FIMBRISTYLIS LITTORALIS	OBL	OBL	obl	-5	OBL	Cyperaceae
Fimbristylis puberula	OBL	OBL	OBL	3	[FACU]	Cyperaceae
Fimbristylis vahlii	OBL	OBL	OBL	-5	OBL	Cyperaceae
FLAVERIA CAMPESTRIS	fac	FAC	FAC	0	FAC	Asteraceae
Fleischmannia incarnata	FACU	FAC	FAC	0	FAC	Asteraceae
Floerkea proserpinacoides	FACW	FAC	FACW	0	FAC	Limnanthaceae
FOENICULUM VULGARE	upl	upl	upl	5	UPL	Apiaceae
FONTANESIA PHILLYREOIDES subsp. FORTUNEI	upl	upl	upl	5	UPL	Oleaceae
Forestiera acuminata	OBL	OBL	OBL	-5	OBL	Oleaceae
FORSYTHIA SUSPENSA	upl	upl	upl	5	UPL	Oleaceae
FRAGARIA × ANANASSA	upl	upl	upl	5	UPL	Rosaceae
Fragaria vesca var. americana	UPL	FACU	UPL	5	UPL	Rosaceae
Fragaria virginiana	FACU	FACU	FACU	3	FACU	Rosaceae
Frasera caroliniensis	upl	upl	upl	5	UPL	Gentianaceae
Fraxinus americana	FACU	FACU	FACU	3	FACU	Oleaceae
Fraxinus biltmoreana	FACU	FACU	FACU	3	FACU	Oleaceae
Fraxinus pennsylvanica var. pennsylvanica	FACW	FACW	FACW	-3	FACW	Oleaceae
Fraxinus pennsylvanica var. subintegerrima	FACW	FACW	FACW	-3	FACW	Oleaceae
Fraxinus profunda	OBL	OBL	OBL	-5	OBL	Oleaceae
Fraxinus quadrangulata	upl	upl	upl	5	UPL	Oleaceae
Fraxinus smallii	FACU	FACU	FACU	3	FACU	Oleaceae
Froelichia floridana var. campestris	upl	upl	upl	5	UPL	Amaranthaceae
Froelichia gracilis	upl	upl	upl	5	UPL	Amaranthaceae
Fuirena simplex var. aristatula	OBL	OBL	OBL	-5	OBL	Cyperaceae
Fuirena simplex var. simplex	OBL	OBL	OBL	-5	OBL	Cyperaceae
FUMARIA OFFICINALIS	upl	upl	upl	5	UPL	Fumariaceae
Gaillardia aestivalis var. flavovirens	upl	upl	upl	5	UPL	Asteraceae
GAILLARDIA PULCHELLA	UPL	UPL	FACU	5	UPL	Asteraceae
Galactia regularis	upl	upl	upl	5	UPL	Fabaceae
GALANTHUS NIVALIS	upl	upl	upl	5	UPL	Liliaceae
Galearis spectabilis	upl	upl	upl	5	UPL	Orchidaceae
GALEOPSIS TETRAHIT	FACU	FACU	FACU	3	FACU	Lamiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
GALINSOGA PARVIFLORA	UPL	UPL	FACU	5	UPL	Asteraceae
GALINSOGA QUADRIRADIATA	FACU	FACU	FACU	3	FACU	Asteraceae
GALIUM ANGLICUM	upl	upl	upl	5	UPL	Rubiaceae
Galium aparine	FACU	FACU	FACU	3	FACU	Rubiaceae
Galium arkansanum	upl	upl	upl	5	UPL	Rubiaceae
Galium asprellum	OBL	OBL	OBL	-5	OBL	Rubiaceae
Galium boreale	FAC	FACU	FAC	0	FAC	Rubiaceae
Galium circaezans	FACU	UPL	FACU	5	UPL	Rubiaceae
Galium concinnum	UPL	UPL	FACU	5	UPL	Rubiaceae
GALIUM DIVARICATUM	FAC	FAC	FAC	0	FAC	Rubiaceae
Galium obtusum	FACW	FACW	FACW	-3	FACW	Rubiaceae
GALIUM PEDEMONTANUM	upl	upl	upl	5	UPL	Rubiaceae
Galium pilosum	upl	upl	upl	5	UPL	Rubiaceae
Galium tinctorium	FACW	OBL	OBL	-5	OBL	Rubiaceae
Galium triflorum	FACU	FACU	FACU	3	FACU	Rubiaceae
GALIUM VERUM	upl	upl	upl	5	UPL	Rubiaceae
Galium virgatum	upl	upl	upl	5	UPL	Rubiaceae
Gamochaeta argyrinea	upl	upl	upl	5	UPL	Asteraceae
GAMOCHAETA PENSYLVANICA	FACU	UPL	UPL	5	UPL	Asteraceae
Gamochaeta purpurea	UPL	UPL	FACU	5	UPL	Asteraceae
Gaura coccinea	upl	upl	upl	5	UPL	Onagraceae
Gaura longiflora	upl	upl	upl	5	UPL	Onagraceae
Gaura parviflora	upl	upl	upl	5	UPL	Onagraceae
GAURA SINUATA	upl	upl	upl	5	UPL	Onagraceae
Gaylussacia baccata	FACU	FACU	FACU	3	FACU	Ericaceae
Gentiana alba	FACU	FACU	FACU	3	FACU	Gentianaceae
Gentiana andrewsii var. andrewsii	FACW	FACW	FACW	-3	FACW	Gentianaceae
Gentiana andrewsii var. dakotica	FACW	FACW	FACW	-3	FACW	Gentianaceae
Gentiana puberulenta	upl	upl	upl	5	UPL	Gentianaceae
Gentianella quinquefolia subsp. occidentalis	FACW	FAC	FAC	-3	FACW	Gentianaceae
Geocarpon minimum	upl	upl	upl	5	UPL	Caryophyllaceae
Geranium carolinianum	upl	upl	upl	5	UPL	Geraniaceae
GERANIUM COLUMBINUM	upl	upl	upl	5	UPL	Geraniaceae
GERANIUM DISSECTUM	upl	upl	upl	5	UPL	Geraniaceae
Geranium maculatum	FACU	FACU	FACU	3	FACU	Geraniaceae
GERANIUM MOLLE	upl	upl	upl	5	UPL	Geraniaceae
GERANIUM PUSILLUM	upl	upl	upl	5	UPL	Geraniaceae
Geum canadense	FAC	FACU	FAC	3	FACU	Rosaceae
Geum fragarioides	upl	upl	upl	5	UPL	Rosaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Geum laciniatum	FACW	FAC	FACW	-3	FACW	Rosaceae
Geum triflorum	upl	upl	FACU	5	UPL	Rosaceae
Geum vernum	FAC	FACU	FACU	3	FACU	Rosaceae
Geum virginianum	FACW	FAC	FACU	3	FACU	Rosaceae
Gillenia stipulata	upl	upl	upl	5	UPL	Rosaceae
Gillenia trifoliata	upl	upl	upl	5	UPL	Rosaceae
GLADIOLUS COMMUNIS	upl	upl	upl	5	UPL	Iridaceae
Glandularia bipinnatifida	upl	upl	upl	5	UPL	Verbenaceae
Glandularia canadensis	upl	upl	upl	5	UPL	Verbenaceae
GLECHOMA HEDERACEA	FACU	FACU	FACU	3	FACU	Lamiaceae
Gleditsia aquatica	OBL	OBL	OBL	-5	OBL	Fabaceae
Gleditsia triacanthos	FAC	FAC	FACU	0	FAC	Fabaceae
GLINUS LOTOIDES	FACW	FACW	OBL	-3	FACW	Molluginaceae
Glyceria acutiflora	OBL	OBL	OBL	-5	OBL	Poaceae
Glyceria septentrionalis var. arkansana	FACW	OBL	OBL	-5	OBL	Poaceae
Glyceria septentrionalis var. septentrionalis	OBL	OBL	OBL	-5	OBL	Poaceae
Glyceria striata	OBL	OBL	OBL	-5	OBL	Poaceae
GLYCINE MAX	upl	upl	upl	5	UPL	Fabaceae
Glycyrrhiza lepidota	FACU	UPL	FACU	5	UPL	Fabaceae
Gonolobus suberosus	FACW	FACW	FACW	-3	FACW	Asclepiadaceae
Goodyera pubescens	UPL	FACU	FAC	3	FACU	Orchidaceae
GOSSYPIUM HIRSUTUM	FACU	FACU	UPL	5	UPL	Malvaceae
Gratiola neglecta	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Gratiola virginiana	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Gratiola viscidula	OBL	OBL	OBL	-5	OBL	Plantaginaceae
GRINDELIA CILIATA	FACU	FACU	UPL	5	UPL	Asteraceae
Grindelia lanceolata	upl	upl	upl	5	UPL	Asteraceae
GRINDELIA SQUARROSA	FACU	FACU	FACU	3	FACU	Asteraceae
GUIZOTIA ABYSSINICA	upl	upl	upl	5	UPL	Asteraceae
GUTIERREZIA TEXANA	upl	upl	upl	5	UPL	Asteraceae
Gymnocladus dioica	upl	upl	upl	5	UPL	Fabaceae
Gymnopogon ambiguus	upl	upl	upl	5	UPL	Poaceae
Hackelia virginiana	FAC	FACU	FACU	3	FACU	Boraginaceae
HALESIA DIPTERA	FAC	FAC	FACU	3	FACU	Styracaceae
Hamamelis vernalis	FACU	FACU	FACW	0	FAC	Hamamelidaceae
Hamamelis virginiana	FACU	FACU	FACU	3	FACU	Hamamelidaceae
Hasteola suaveolens	FACW	FACW	FACW	-3	FACW	Asteraceae
Hedeoma hispida	upl	upl	upl	5	UPL	Lamiaceae
Hedeoma pulegioides	upl	upl	upl	5	UPL	Lamiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO	FAMILY
HEDERA HELIX	FACU	FACU	UPL	3 FACU	Araliaceae
HELENIUM AMARUM	FACU	FACU	FACU	3 FACU	Asteraceae
Helenium autumnale	FACW	FACW	FACW	-3 FACW	Asteraceae
Helenium flexuosum	FACW	FAC	FAC	0 FAC	Asteraceae
Helenium virginicum	OBL	OBL	OBL	-5 OBL	Asteraceae
Helianthemum bicknellii	upl	upl	upl	5 UPL	Cistaceae
Helianthemum canadense	upl	upl	upl	5 UPL	Cistaceae
Helianthus × laetiflorus	upl	upl	upl	5 UPL	Asteraceae
Helianthus angustifolius	FACW	FACW	FACW	-3 FACW	Asteraceae
Helianthus annuus	FAC	FAC	FACU	3 FACU	Asteraceae
Helianthus decapetalus	UPL	FACU	UPL	5 UPL	Asteraceae
Helianthus divaricatus	upl	upl	upl	5 UPL	Asteraceae
Helianthus grosseserratus	FAC	FACW	FACW	0 FAC	Asteraceae
Helianthus hirsutus	upl	upl	upl	5 UPL	Asteraceae
Helianthus maximilianii	UPL	UPL	UPL	5 UPL	Asteraceae
Helianthus microcephalus	UPL	UPL	FACU	5 UPL	Asteraceae
Helianthus mollis	upl	upl	upl	5 UPL	Asteraceae
Helianthus occidentalis	FACU	UPL	FACU	5 UPL	Asteraceae
Helianthus pauciflorus subsp. pauciflorus	upl	upl	upl	5 UPL	Asteraceae
HELIANTHUS PAUCIFLORUS subsp. SUBRHOMBOIDEUS	upl	upl	upl	5 UPL	Asteraceae
HELIANTHUS PETIOLARIS	upl	upl	upl	5 UPL	Asteraceae
Helianthus salicifolius	upl	upl	upl	5 UPL	Asteraceae
Helianthus silphioides	upl	upl	upl	5 UPL	Asteraceae
Helianthus strumosus	UPL	FACU	FACU	0 [FAC]	Asteraceae
Helianthus tuberosus	FACU	FACU	FACU	3 FACU	Asteraceae
Heliopsis helianthoides var. helianthoides	UPL	FACU	FACU	0 [FAC]	Asteraceae
Heliopsis helianthoides var. scabra	UPL	FACU	FACU	0 [FAC]	Asteraceae
HELIOTROPIUM AMPLEXICAULE	upl	upl	upl	5 UPL	Heliotropaceae
Heliotropium curassavicum	OBL	OBL	OBL	-5 OBL	Heliotropaceae
HELIOTROPIUM INDICUM	FAC	FAC	FACW	0 FAC	Heliotropaceae
HELIOTROPIUM PROCUMBENS	FACW	FACW	facw	-3 FACW	Heliotropaceae
Heliotropium tenellum	upl	upl	upl	5 UPL	Heliotropaceae
HELMINOTHECA ECHIOIDES	upl	upl	upl	5 UPL	Asteraceae
HEMEROCALLIS FULVA	UPL	FACU	UPL	5 UPL	Liliaceae
Heracleum sphondylium subsp. montanum	FAC	FAC	FACW	0 FAC	Apiaceae
HESPERIS MATRONALIS	FACU	FACU	FACU	3 FACU	Brassicaceae
Heteranthera dubia	OBL	OBL	OBL	-5 OBL	Pontederiaceae
Heteranthera limosa	OBL	OBL	OBL	-5 OBL	Pontederiaceae
Heteranthera multiflora	obl	obl	obl	-5 OBL	Pontederiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Heteranthera reniformis	OBL	OBL	OBL	-5	OBL	Pontederiaceae
Heteranthera rotundifolia	obl	obl	obl	-5	[OBL]	Pontederiaceae
Heterotheca camporum	upl	upl	upl	5	UPL	Asteraceae
Heterotheca canescens	upl	upl	upl	5	UPL	Asteraceae
Heterotheca subaxillaris	UPL	UPL	UPL	5	UPL	Asteraceae
Heuchera americana	FACU	FACU	FACU	3	FACU	Saxifragaceae
Heuchera parviflora var. parviflora	upl	upl	upl	5	UPL	Saxifragaceae
Heuchera parviflora var. puberula	upl	upl	upl	5	UPL	Saxifragaceae
Heuchera richardsonii	FACU	FAC	FACU	3	FACU	Saxifragaceae
Heuchera villosa	upl	upl	upl	5	UPL	Saxifragaceae
Hexalectris spicata	FACU	UPL	UPL	5	UPL	Orchidaceae
Hibiscus laevis	OBL	OBL	OBL	-5	OBL	Malvaceae
Hibiscus lasiocarpos	OBL	OBL	OBL	-5	OBL	Malvaceae
HIBISCUS SYRIACUS	upl	upl	upl	5	UPL	Malvaceae
HIBISCUS TRIONUM	upl	upl	upl	5	UPL	Malvaceae
HIERACIUM CAESPITOSUM	upl	upl	upl	5	UPL	Asteraceae
Hieracium gronovii	UPL	UPL	UPL	5	UPL	Asteraceae
Hieracium longipilum	upl	upl	upl	5	UPL	Asteraceae
Hieracium scabrum	upl	upl	upl	5	UPL	Asteraceae
HOLCUS LANATUS	FACU	FAC	FACU	3	FACU	Poaceae
HOLOSTEUM UMBELLATUM	upl	upl	upl	5	UPL	Caryophyllaceae
Hordeum jubatum	FAC	FAC	FAC	0	FAC	Poaceae
Hordeum pusillum	FACU	FAC	FAC	3	FACU	Poaceae
HORDEUM VULGARE	upl	upl	upl	5	UPL	Poaceae
Hottonia inflata	OBL	OBL	OBL	-5	OBL	Primulaceae
Houstonia caerulea	FAC	FACU	FAC	3	FACU	Rubiaceae
Houstonia longifolia var. longifolia	upl	upl	upl	5	UPL	Rubiaceae
Houstonia longifolia var. tenuifolia	upl	upl	upl	5	UPL	Rubiaceae
Houstonia micrantha	upl	upl	upl	5	UPL	Rubiaceae
Houstonia nigricans	upl	upl	upl	5	UPL	Rubiaceae
Houstonia purpurea	upl	upl	upl	5	UPL	Rubiaceae
Houstonia pusilla	FACU	FAC	FACU	3	FACU	Rubiaceae
Houstonia rosea	upl	upl	upl	5	UPL	Rubiaceae
HUMULUS JAPONICUS	FAC	FACU	FACU	3	FACU	Cannabaceae
Humulus lupulus var. lupulus	FACU	FACU	FACU	3	FACU	Cannabaceae
Humulus lupulus var. neomexicanus	FACU	FACU	FACU	3	FACU	Cannabaceae
Humulus lupulus var. pubescens	FACU	FACU	FACU	3	FACU	Cannabaceae
Huperzia lucidula	FACW	FACW	FACW	-3	FACW	Lycopodiaceae
Huperzia porophila	UPL	FACU	FACU	3	FACU	Lycopodiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Hydrangea arborescens	UPL	FACU	FACU	3	FACU	Hydrangeaceae
Hydrastis canadensis	upl	upl	upl	5	UPL	Ranunculaceae
HYDRILLA VERTICILLATA	OBL	OBL	obl	-5	OBL	Hydrocharitaceae
Hydrocotyle ranunculoides	OBL	OBL	OBL	-5	OBL	Apiaceae
Hydrocotyle verticillata	OBL	OBL	OBL	-5	OBL	Apiaceae
Hydrolea ovata	OBL	OBL	OBL	-5	OBL	Hydroleaceae
Hydrolea uniflora	OBL	OBL	OBL	-5	OBL	Hydroleaceae
Hydrophyllum appendiculatum	upl	upl	upl	5	UPL	Hydrophyllaceae
Hydrophyllum canadense	FACW	FACU	FACW	0	FAC	Hydrophyllaceae
Hydrophyllum virginianum	FACW	FAC	FAC	0	FAC	Hydrophyllaceae
Hylodesmum glutinosim	upl	upl	upl	5	UPL	Fabaceae
Hylodesmum nudiflorum	upl	upl	upl	5	UPL	Fabaceae
Hylodesmum pauciflorum	upl	upl	upl	5	UPL	Fabaceae
Hymenocallis caroliniana	OBL	OBL	OBL	-5	OBL	Liliaceae
Hymenopappus scabiosaeus	upl	upl	upl	5	UPL	Asteraceae
Hypericum adpressum	OBL	OBL	OBL	-5	OBL	Clusiaceae
Hypericum ascyron subsp. pyramidatum	FAC	FAC	FAC	0	FAC	Clusiaceae
Hypericum drummondii	FACU	UPL	FACU	3	FACU	Clusiaceae
Hypericum gentianoides	FACU	UPL	FACU	5	UPL	Clusiaceae
Hypericum gymnanthum	FACW	OBL	OBL	-5	OBL	Clusiaceae
Hypericum hypericoides	FAC	FACU	FACU	3	FACU	Clusiaceae
Hypericum lobocarpum	upl	upl	upl	5	UPL	Clusiaceae
Hypericum majus	FACW	FACW	FACW	-3	FACW	Clusiaceae
Hypericum mutilum	FACW	FACW	FACW	-3	FACW	Clusiaceae
HYPERICUM PERFORATUM	FACU	FAC	FACU	3	FACU	Clusiaceae
Hypericum prolificum	FAC	FACU	FACU	3	FACU	Clusiaceae
Hypericum pseudomaculatum	upl	upl	upl	5	UPL	Clusiaceae
Hypericum punctatum	FAC	FAC	FAC	0	FAC	Clusiaceae
Hypericum sphaerocarpum	FACU	FAC	FACU	3	FACU	Clusiaceae
Hypericum strangulum	FAC	FACU	FACU	3	FACU	Clusiaceae
HYPOCHAERIS RADICATA	UPL	UPL	FACU	5	UPL	Asteraceae
Hypoxis hirsuta	FACW	FAC	FAC	0	FAC	Liliaceae
Ilex decidua	FACW	FACW	FACW	-3	FACW	Aquifoliaceae
Ilex opaca	FAC	FACU	FACU	3	FACU	Aquifoliaceae
Ilex verticillata	FACW	FACW	FACW	-3	FACW	Aquifoliaceae
ILEX VOMITORIA	FAC	FAC	fac	0	FAC	Aquifoliaceae
IMPATIENS BALSAMINEA	UPL	UPL	FACU	5	UPL	Balsaminaceae
Impatiens capensis	FACW	FACW	FACW	-3	FACW	Balsaminaceae
Impatiens pallida	FACW	FACW	FACW	-3	FACW	Balsaminaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
INULA BRITANNICA	upl	upl	upl	5	UPL	Asteraceae
INULA HELENIUM	UPL	FACU	FACU	5	UPL	Asteraceae
Iodanthus pinnatifidus	FACW	FACW	FACW	-3	FACW	Brassicaceae
Ionactis linariifolius	upl	upl	upl	5	UPL	Asteraceae
IPOMOEA AMNICOLA	FACW	facw	FACW	-3	FACW	Convolvulaceae
IPOMOEA COCCINEA	FAC	FACU	FAC	3	FACU	Convolvulaceae
IPOMOEA HEDERACEA	FACU	FACU	FAC	3	FACU	Convolvulaceae
Ipomoea lacunosa	FAC	FACW	FACW	0	FAC	Convolvulaceae
Ipomoea pandurata	FACU	FACU	FACU	3	FACU	Convolvulaceae
IPOMOEA PURPUREA	UPL	UPL	FACU	5	UPL	Convolvulaceae
IPOMOEA QUAMOCLIT	FACU	UPL	FACU	5	UPL	Convolvulaceae
IPOMOEA TRICOLOR	upl	upl	upl	5	UPL	Convolvulaceae
IPOMOPSIS RUBRA	upl	upl	upl	5	UPL	Polemoniaceae
Iresine rhizomatosa	FACW	FACW	FACW	-3	FACW	Amaranthaceae
Iris brevicaulis	OBL	OBL	OBL	-5	OBL	Iridaceae
Iris cristata	upl	upl	upl	5	UPL	Iridaceae
Iris fulva	OBL	OBL	OBL	-5	OBL	Iridaceae
IRIS GERMANICA	upl	upl	upl	5	UPL	Iridaceae
IRIS ORIENTALIS	upl	upl	upl	5	UPL	Iridaceae
IRIS PALLIDA	upl	upl	upl	5	UPL	Iridaceae
IRIS PSEUDOACORUS	OBL	OBL	OBL	-5	OBL	Iridaceae
IRIS PUMILA	upl	upl	upl	5	UPL	Iridaceae
IRIS VERNA	upl	upl	upl	5	UPL	Iridaceae
Iris virginica var. shrevei	OBL	OBL	OBL	-5	OBL	Iridaceae
ISATIS TINCTORIA	upl	upl	upl	5	UPL	Brassicaceae
Isoetes butleri	OBL	FACW	OBL	-5	OBL	Isoetaceae
Isoetes engelmannii	OBL	OBL	OBL	-5	OBL	Isoetaceae
Isoetes melanopoda	OBL	OBL	OBL	-5	OBL	Isoetaceae
Isolepis carinata	FACW	FACW	FACW	-3	FACW	Cyperaceae
Isolepis molesta	OBL	OBL	OBL	-5	OBL	Cyperaceae
Isopyrum biternatum	FACW	FACU	FAC	3	FACU	Ranunculaceae
Isotria medeoloides	FACU	FACU	FACU	3	FACU	Orchidaceae
Isotria verticillata	FACU	FACU	FAC	3	FACU	Orchidaceae
Itea virginica	FACW	OBL	OBL	-5	OBL	Iteaceae
IVA ANGUSTIFOLIA	upl	upl	upl	5	UPL	Asteraceae
Iva annua	FAC	FAC	FAC	0	FAC	Asteraceae
JACQUEMONTIA TAMNIFOLIA	FACU	FACU	UPL	3	FACU	Convolvulaceae
JASMINUM NUDIFLORUM	upl	upl	upl	5	UPL	Oleaceae
Juglans cinerea	FACU	FACU	FACU	3	FACU	Juglandaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Juglans nigra	UPL	FACU	FACU	3	FACU	Juglandaceae
Juncus acuminatus	OBL	OBL	OBL	-5	OBL	Juncaceae
Juncus alpinoarticulatus	obl	OBL	OBL	-5	OBL	Juncaceae
Juncus balticus subsp. littoralis	OBL	OBL	OBL	-5	OBL	Juncaceae
Juncus biflorus	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus brachycarpus	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus brachyphyllus	FAC	FAC	FAC	0	FAC	Juncaceae
Juncus bufonius	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus canadensis	OBL	OBL	OBL	-5	OBL	Juncaceae
Juncus debilis	OBL	OBL	OBL	-5	OBL	Juncaceae
Juncus diffusissimus	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus dudleyi	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus effusus subsp. solutus	OBL	FACW	OBL	-5	OBL	Juncaceae
Juncus filipendulus	FAC	FAC	fac	0	FAC	Juncaceae
JUNCUS GERARDII	OBL	FACW	OBL	-5	OBL	Juncaceae
Juncus interior	FACU	FACU	FAC	3	FACU	Juncaceae
Juncus marginatus	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus nodatus	OBL	OBL	OBL	-5	OBL	Juncaceae
Juncus nodosus	OBL	OBL	OBL	-5	OBL	Juncaceae
Juncus scirpoides	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus secundus	FAC	FACU	FAC	3	FACU	Juncaceae
Juncus subcaudatus	FAC	OBL	OBL	-5	OBL	Juncaceae
Juncus tenuis var. anthelatus	FACW	FACW	FAC	0	FAC	Juncaceae
Juncus tenuis var. tenuis	FAC	FAC	FAC	0	FAC	Juncaceae
Juncus torreyi	FACW	FACW	FACW	-3	FACW	Juncaceae
Juncus validus	FACW	FACW	FACW	-3	FACW	Juncaceae
Juniperus ashei	upl	upl	upl	5	UPL	Cupressaceae
Juniperus virginiana	FACU	FACU	FACU	3	FACU	Cupressaceae
Justicia americana	OBL	OBL	OBL	-5	OBL	Acanthaceae
Justicia ovata	OBL	OBL	OBL	-5	OBL	Acanthaceae
KALLSTROEMIA PARVIFLORA	upl	upl	upl	5	UPL	Zygophyllaceae
KICKXIA ELATINE	FACU	FAC	FAC	3	FACU	Plantaginaceae
KICKXIA SPURIA	upl	upl	upl	5	UPL	Plantaginaceae
KNAUTIA ARVENSIS	upl	upl	upl	5	UPL	Dipsacaceae
KOCHIA SCOPARIA	FACU	UPL	FACU	3	FACU	Chenopodiaceae
Koeleria macrantha	upl	upl	upl	5	UPL	Poaceae
KOELRUETERIA PANICULATA	upl	upl	upl	5	UPL	Sapindaceae
KOLKWITZIA AMABILIS	upl	upl	upl	5	UPL	Caprifoliaceae
Krigia biflora	FACU	FACU	FACU	3	FACU	Asteraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO	FAMILY
Krigia caespitosa	FAC	FAC	FACU	3 FACU	Asteraceae
Krigia dandelion	FACU	FAC	FACU	3 FACU	Asteraceae
Krigia occidentalis	upl	upl	upl	5 UPL	Asteraceae
Krigia virginica	FACU	UPL	UPL	5 UPL	Asteraceae
KUMMEROWIA STIPULACEA	FACU	FACU	FACU	3 FACU	Fabaceae
KUMMEROWIA STRIATA	FACU	FACU	FACU	3 FACU	Fabaceae
KYLLINGA GRACILLIMA	FACU	FACU	FACW	0 FAC	Cyperaceae
Kyllinga pumila	FACW	FACW	FACW	-3 FACW	Cyperaceae
LABLAB PURPUREUS	upl	upl	upl	5 UPL	Fabaceae
Lactuca canadensis	FACU	FACU	FACU	3 FACU	Asteraceae
Lactuca floridana	FACU	FACU	FACU	3 FACU	Asteraceae
Lactuca hirsuta	upl	upl	upl	5 UPL	Asteraceae
Lactuca ludoviciana	FAC	UPL	FACU	5 UPL	Asteraceae
LACTUCA SALIGNA	FACU	UPL	FACU	3 FACU	Asteraceae
LACTUCA SERRIOLA	FAC	FAC	FACU	3 FACU	Asteraceae
Lactuca tatarica subsp. pulchella	FAC	FAC	FAC	0 FAC	Asteraceae
LAGENARIA SICERARIA	upl	upl	upl	5 UPL	Cucurbitaceae
LAMIUM AMPLEXICAULE	upl	upl	upl	5 UPL	Lamiaceae
LAMIUM HYBRIDUM	upl	upl	upl	5 UPL	Lamiaceae
LAMIUM PURPUREUM	upl	upl	upl	5 UPL	Lamiaceae
Laportea canadensis	FACW	FAC	FACW	-3 FACW	Urticaceae
LAPPULA REDOWSKII	upl	upl	upl	5 UPL	Boraginaceae
LAPPULA SQUARROSA	upl	upl	upl	5 UPL	Boraginaceae
LAPSANA COMMUNIS	FAC	FACU	FACU	3 FACU	Asteraceae
LATHYRUS HIRSUTUS	FAC	FAC	FACU	3 FACU	Fabaceae
LATHYRUS LATIFOLIUS	upl	upl	upl	5 UPL	Fabaceae
Lathyrus palustris	OBL	FACW	FACW	-5 OBL	Fabaceae
Lathyrus pusillus	FAC	FAC	UPL	3 FACU	Fabaceae
LATHYRUS SYLVESTRIS	upl	upl	upl	5 UPL	Fabaceae
LATHYRUS TUBEROSUS	upl	upl	upl	5 UPL	Fabaceae
Lathyrus venosus	FAC	FACW	FAC	5 [UPL]	Fabaceae
LAVATERA TRIMESTRIS	upl	upl	upl	5 UPL	Malvaceae
Leavenworthia uniflora	FAC	FAC	FACU	3 FACU	Brassicaceae
Lechea mucronata	upl	upl	upl	5 UPL	Cistaceae
Lechea racemulosa	upl	upl	upl	5 UPL	Cistaceae
Lechea tenuifolia	upl	upl	upl	5 UPL	Cistaceae
Leersia lenticularis	OBL	OBL	OBL	-5 OBL	Poaceae
Leersia oryzoides	OBL	OBL	OBL	-5 OBL	Poaceae
Leersia virginica var. ovata	FACW	FACW	FACW	-3 FACW	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Leersia virginica var. virginica	FACW	FACW	FACW	-3	FACW	Poaceae
Leitneria floridana	OBL	OBL	obl	-5	OBL	Simaroubaceae
Lemna aequinoctialis	OBL	OBL	OBL	-5	OBL	Lemnaceae
Lemna minor	OBL	OBL	OBL	-5	OBL	Lemnaceae
Lemna minuta	OBL	OBL	OBL	-5	OBL	Lemnaceae
Lemna obscura	OBL	OBL	OBL	-5	OBL	Lemnaceae
Lemna perpusilla	OBL	OBL	OBL	-5	OBL	Lemnaceae
Lemna trisulca	OBL	OBL	OBL	-5	OBL	Lemnaceae
Lemna turionifera	OBL	OBL	OBL	-5	OBL	Lemnaceae
Lemna valdiviana	OBL	OBL	OBL	-5	OBL	Lemnaceae
LEONTODON TARAXACOIDES	upl	upl	upl	5	UPL	Asteraceae
LEONURUS CARDIACA	upl	upl	upl	5	UPL	Lamiaceae
LEONURUS JAPONICUS	upl	upl	upl	5	UPL	Lamiaceae
LEONURUS MARRUBIASTRUM	upl	upl	upl	5	UPL	Lamiaceae
LEPIDIUM APPELIANUM	FAC	FAC	UPL	5	UPL	Brassicaceae
LEPIDIUM CAMPESTRE	upl	upl	upl	5	UPL	Brassicaceae
LEPIDIUM CHALAPENSE	upl	upl	upl	5	UPL	Brassicaceae
LEPIDIUM DENSIFLORUM	FACU	FAC	FAC	3	FACU	Brassicaceae
LEPIDIUM DIDYMUM	upl	upl	upl	5	UPL	Brassicaceae
LEPIDIUM DRABA	upl	upl	upl	5	UPL	Brassicaceae
LEPIDIUM LATIFOLIUM	FAC	FAC	FACW	0	FAC	Brassicaceae
LEPIDIUM PERFOLIATUM	FACU	UPL	FAC	3	FACU	Brassicaceae
LEPIDIUM RUDERALE	upl	upl	upl	5	UPL	Brassicaceae
Lepidium virginicum	UPL	FACU	FACU	3	FACU	Brassicaceae
LEPTOCHLOA DUBIA	upl	upl	upl	5	UPL	Poaceae
Leptochloa fusca subsp. fascicularis	FACW	FACW	OBL	-3	FACW	Poaceae
LEPTOCHLOA FUSCA subsp. UNINERVIA	FACW	FACW	OBL	-3	FACW	Poaceae
Leptochloa panicea subsp. brachiata	FACW	FACW	FACW	-3	FACW	Poaceae
Leptochloa panicea subsp. mucronata	FACW	FACW	FACW	-3	FACW	Poaceae
Leptochloa panicoides	FACW	FACW	OBL	-3	FACW	Poaceae
LESPEDEZA BICOLOR	upl	upl	upl	5	UPL	Fabaceae
Lespedeza capitata	FACU	FACU	FACU	3	FACU	Fabaceae
LESPEDEZA CUNEATA	FACU	FACU	UPL	3	FACU	Fabaceae
Lespedeza frutescens	upl	upl	upl	5	UPL	Fabaceae
Lespedeza hirta	upl	upl	upl	5	UPL	Fabaceae
Lespedeza prairea	upl	upl	upl	5	UPL	Fabaceae
Lespedeza procumbens	upl	upl	upl	5	UPL	Fabaceae
Lespedeza repens	upl	upl	upl	5	UPL	Fabaceae
Lespedeza stuevei	upl	upl	upl	5	UPL	Fabaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
LESPEDEZA THUNBERGII	upl	upl	upl	5	UPL	Fabaceae
Lespedeza violacea	upl	upl	upl	5	UPL	Fabaceae
Lespedeza virginica	upl	upl	upl	5	UPL	Fabaceae
LEUCANTHEMUM VULGARE	UPL	UPL	UPL	5	UPL	Asteraceae
LEUCOJUM AESTIVUM	upl	upl	upl	5	UPL	Liliaceae
Leucospora multifida	OBL	OBL	FACW	-3	FACW	Plantaginaceae
LEVISTICUM OFFICINALE	upl	upl	upl	5	UPL	Apiaceae
Liatris aspera	upl	upl	upl	5	UPL	Asteraceae
Liatris cylindracea	upl	upl	upl	5	UPL	Asteraceae
Liatris mucronata	upl	upl	upl	5	UPL	Asteraceae
Liatris punctata	upl	upl	upl	5	UPL	Asteraceae
Liatris pycnostachya	FACU	FACU	FAC	0	FAC	Asteraceae
Liatris scariosa var. nieuwlandii	UPL	FACU	UPL	5	UPL	Asteraceae
Liatris spicata	FAC	FAC	FAC	0	FAC	Asteraceae
Liatris squarrosa var. hirsuta	upl	upl	upl	5	UPL	Asteraceae
Liatris squarrosa var. squarrosa	upl	upl	upl	5	UPL	Asteraceae
Liatris squarrulosa	upl	upl	upl	5	UPL	Asteraceae
Ligusticum canadense	FAC	FAC	FAC	0	FAC	Apiaceae
LIGUSTRUM OBTUSIFOLIUM	upl	upl	upl	5	UPL	Oleaceae
LIGUSTRUM OVALIFOLIUM	upl	upl	upl	5	UPL	Oleaceae
LIGUSTRUM SINENSE	FAC	FACU	FACU	3	FACU	Oleaceae
LIGUSTRUM VULGARE	UPL	FACU	FACU	3	FACU	Oleaceae
LILIUM LANCIFOLIUM	upl	upl	upl	5	UPL	Liliaceae
Lilium michiganense	FACW	FACW	FACW	-3	FACW	Liliaceae
Lilium philadelphicum var. andinum	FACU	FACU	FAC	3	FACU	Liliaceae
Lilium superbum	FACW	FACW	FACW	-3	FACW	Liliaceae
Limnobium spongia	OBL	OBL	OBL	-5	OBL	Hydrocharitaceae
Limnosciadium pinnatum	FACW	FACW	FACW	-3	FACW	Apiaceae
LINARIA VULGARIS	upl	upl	upl	5	UPL	Plantaginaceae
Lindera benzoin	FACW	FAC	FACW	0	FAC	Lauraceae
Lindera melissifolia	FACW	OBL	obl	-5	OBL	Lauraceae
Lindernia dubia var. anagallidea	OBL	OBL	OBL	-5	OBL	Linderniaceae
Lindernia dubia var. dubia	OBL	OBL	OBL	-5	OBL	Linderniaceae
Linum floridanum	FAC	FAC	FAC	0	FAC	Linaceae
Linum medium var. texanum	FAC	FACU	FACU	3	FACU	Linaceae
LINUM RIGIDUM	upl	upl	upl	5	UPL	Linaceae
Linum striatum	FACW	FACW	FACW	-3	FACW	Linaceae
Linum sulcatum	upl	upl	upl	5	UPL	Linaceae
LINUM USITATISSIMUM	upl	upl	upl	5	UPL	Linaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Linum virginianum	FAC	FACU	FAC	0	FAC	Linaceae
Liparis liliifolia	FACU	FACU	FACU	3	FACU	Orchidaceae
Liparis loeselii	FACW	FACW	FACW	-3	FACW	Orchidaceae
Lipocarpha aristulata	FACW	FACW	OBL	-3	FACW	Cyperaceae
Lipocarpha drummondii	OBL	OBL	FACW	-3	FACW	Cyperaceae
Lipocarpha micrantha	FACW	FACW	OBL	-3	FACW	Cyperaceae
Lippia lanceolata	OBL	OBL	OBL	-5	OBL	Verbenaceae
Lippia nodiflora	FAC	FACW	FACW	-3	FACW	Verbenaceae
Liquidamber styraciflua	FAC	FAC	FACW	0	FAC	Hamamelidaceae
Liriodendron tulipifera	FACU	FACU	FACU	3	FACU	Magnoliaceae
LIRIOPE MUSCARI	upl	upl	upl	5	UPL	Liliaceae
LIRIOPE SPICATA	upl	upl	upl	5	UPL	Liliaceae
Listera australis	FACW	FACW	facw	-3	FACW	Orchidaceae
Lithospermum canescens	upl	upl	upl	5	UPL	Boraginaceae
Lithospermum carolinense	upl	upl	upl	5	UPL	Boraginaceae
Lithospermum incisum	upl	upl	upl	5	UPL	Boraginaceae
Lithospermum latifolium	upl	upl	upl	5	UPL	Boraginaceae
Lobelia cardinalis	FACW	FACW	OBL	-3	FACW	Campanulaceae
Lobelia inflata	FAC	FACU	FACU	3	FACU	Campanulaceae
Lobelia puberula	FACW	FACW	FACW	-3	FACW	Campanulaceae
Lobelia siphilitica	OBL	FACW	OBL	-5	OBL	Campanulaceae
Lobelia spicata	FAC	FAC	FAC	0	FAC	Campanulaceae
LOBULARIA MARITIMA	upl	upl	upl	5	UPL	Brassicaceae
LOLIUM PERENNE var. ARISTATUM	FACU	FACU	FACU	3	FACU	Poaceae
LOLIUM PERENNE var. PERENNE	FACU	FACU	FACU	3	FACU	Poaceae
LOLIUM PERSICUM	upl	upl	upl	5	UPL	Poaceae
LOLIUM RIGIDUM	upl	upl	upl	5	UPL	Poaceae
LOLIUM TEMULENTUM	upl	upl	upl	5	UPL	Poaceae
Lomatium foeniculaceum	upl	upl	upl	5	UPL	Apiaceae
LONICERA × BELLA	UPL	FACU	FACU	3	FACU	Caprifoliaceae
LONICERA × PERPUSII	upl	upl	upl	5	UPL	Caprifoliaceae
Lonicera dioica	FACU	FACU	FACU	3	FACU	Caprifoliaceae
Lonicera flava	upl	upl	upl	5	UPL	Caprifoliaceae
LONICERA FRAGRANTISSIMA	upl	upl	upl	5	UPL	Caprifoliaceae
LONICERA JAPONICA	FACU	FAC	FACU	3	FACU	Caprifoliaceae
LONICERA MAACKII	upl	upl	upl	5	UPL	Caprifoliaceae
Lonicera reticulata	upl	upl	upl	5	UPL	Caprifoliaceae
LONICERA SEMPERVIRENS	FACU	FACU	FACU	3	FACU	Caprifoliaceae
LOTUS CORNICULATUS	FACU	FACU	FACU	3	FACU	Fabaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Ludwigia alternifolia	OBL	FACW	OBL	-5	OBL	Onagraceae
Ludwigia decurrens	OBL	OBL	OBL	-5	OBL	Onagraceae
Ludwigia glandulosa	OBL	OBL	OBL	-5	OBL	Onagraceae
LUDWIGIA GRANDIFLORA	OBL	OBL	obl	-5	OBL	Onagraceae
Ludwigia leptocarpa	OBL	OBL	OBL	-5	OBL	Onagraceae
Ludwigia linearis	OBL	OBL	obl	-5	OBL	Onagraceae
Ludwigia microcarpa	OBL	OBL	obl	-5	OBL	Onagraceae
Ludwigia palustris	OBL	OBL	OBL	-5	OBL	Onagraceae
Ludwigia peploides subsp. glabrescens	OBL	OBL	OBL	-5	OBL	Onagraceae
Ludwigia polycarpa	OBL	OBL	OBL	-5	OBL	Onagraceae
LUNARIA ANNUA	upl	upl	upl	5	UPL	Brassicaceae
Luzula campestris var. bulbosa	FACU	FACU	FACU	3	FACU	Juncaceae
Luzula campestris var. echinata	FAC	FACU	FACU	3	FACU	Juncaceae
Luzula campestris var. multiflora	FACU	FACU	FACU	3	FACU	Juncaceae
LYCHNIS CORONARIA	upl	upl	upl	5	UPL	Caryophyllaceae
LYCIUM BARBARUM	UPL	UPL	UPL	5	UPL	Solanaceae
LYCIUM CHINENSE	upl	upl	upl	5	UPL	Solanaceae
Lycopodium dendroideum	upl	upl	upl	5	UPL	Lycopodiaceae
Lycopodium digitatum	upl	upl	upl	5	UPL	Lycopodiaceae
Lycopodium tristachyum	upl	upl	upl	5	UPL	Lycopodiaceae
Lycopus americanus	OBL	OBL	OBL	-5	OBL	Lamiaceae
Lycopus asper	obl	obl	OBL	-5	OBL	Lamiaceae
Lycopus rubellus	OBL	OBL	OBL	-5	OBL	Lamiaceae
Lycopus uniflorus	OBL	OBL	OBL	-5	OBL	Lamiaceae
Lycopus virginicus	OBL	OBL	OBL	-5	OBL	Lamiaceae
Lygodesmia juncea	upl	upl	upl	5	UPL	Asteraceae
Lyonia mariana	FAC	FAC	fac	0	FAC	Ericaceae
Lysimachia ciliata	FACW	FACW	FACW	-3	FACW	Primulaceae
Lysimachia hybrida	OBL	OBL	OBL	-5	OBL	Primulaceae
Lysimachia lanceolata	FAC	FAC	FAC	0	FAC	Primulaceae
LYSIMACHIA NUMMULARIA	FACW	FACW	FACW	-3	FACW	Primulaceae
Lysimachia quadriflora	OBL	FACW	OBL	-5	OBL	Primulaceae
Lysimachia radicans	OBL	OBL	OBL	-5	OBL	Primulaceae
Lysimachia terrestris	OBL	OBL	OBL	-5	OBL	Primulaceae
Lysimachia thyrsiflora	OBL	OBL	OBL	-5	OBL	Primulaceae
LYSIMACHIA VULGARIS	FAC	FAC	FACW	0	FAC	Primulaceae
Lythrum alatum	OBL	FACW	OBL	-5	OBL	Lythraceae
LYTHRUM SALICARIA	OBL	FACW	OBL	-5	OBL	Lythraceae
MACLURA POMIFERA	FACU	UPL	FACU	3	FACU	Moraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO	FAMILY
Magnolia acuminata	FACU	FACU	FACU	3 FACU	Magnoliaceae
MAGNOLIA TRIPETALA	FACU	FACU	FACU	3 FACU	Magnoliaceae
Maianthemum racemosum	FACU	FACU	FACU	3 FACU	Liliaceae
Maianthemum stellatum	FACU	FACW	FAC	0 FAC	Liliaceae
Malaxis unifolia	FAC	FAC	FAC	0 FAC	Orchidaceae
MALUS × SOULARDII	upl	upl	upl	5 UPL	Rosaceae
Malus angustifolia	upl	upl	upl	5 UPL	Rosaceae
MALUS BACCATA	upl	upl	upl	5 UPL	Rosaceae
Malus coronaria	upl	upl	upl	5 UPL	Rosaceae
MALUS DOMESTICA	upl	upl	upl	5 UPL	Rosaceae
MALUS FLORIBUNDA	upl	upl	upl	5 UPL	Rosaceae
Malus ioensis	upl	upl	upl	5 UPL	Rosaceae
MALUS SIEBOLDII	upl	upl	upl	5 UPL	Rosaceae
MALVA MOSCHATA	UPL	UPL	UPL	5 UPL	Malvaceae
MALVA NEGLECTA	upl	upl	upl	5 UPL	Malvaceae
MALVA PARVIFLORA	upl	upl	upl	5 UPL	Malvaceae
MALVA PUSILLA	upl	upl	upl	5 UPL	Malvaceae
MALVA SYLVESTRIS	upl	upl	upl	5 UPL	Malvaceae
MALVA VERTICILLATA	upl	upl	upl	5 UPL	Malvaceae
Malvastrum angustum	upl	upl	upl	5 UPL	Malvaceae
Manfreda virginica	upl	upl	upl	5 UPL	Agavaceae
MARRUBIUM VULGARE	FACU	UPL	FAC	3 FACU	Lamiaceae
Marshallia caespitosa var. caespitosa	FACU	FACU	UPL	5 UPL	Asteraceae
Marshallia caespitosa var. signata	FACU	FACU	UPL	5 UPL	Asteraceae
MARSILEA MUTICA	OBL	OBL	OBL	-5 OBL	Marsileaceae
MARSILEA QUADRIFOLIA	OBL	OBL	OBL	-5 OBL	Marsileaceae
Matelea baldwyniana	upl	upl	upl	5 UPL	Asclepiadaceae
Matelea decipiens	upl	upl	upl	5 UPL	Asclepiadaceae
MATRICARIA CHAMOMILLA	upl	upl	upl	5 UPL	Asteraceae
MATRICARIA DISCOIDEA	FACU	FACU	FACU	3 FACU	Asteraceae
Matteuccia struthiopteris var. pensylvanica	FACW	FACW	FACW	-3 FACW	Dryopteridaceae
MAZUS PUMILUS	FAC	FACU	UPL	3 FACU	Phrymaceae
Mecardonia acuminata	FACW	OBL	OBL	-5 OBL	Plantaginaceae
Medeola virginiana	FACU	facu	FACU	3 FACU	Liliaceae
MEDICAGO ARABICA	upl	upl	upl	5 UPL	Fabaceae
MEDICAGO LUPULINA	UPL	FACU	FACU	3 FACU	Fabaceae
MEDICAGO MINIMA	upl	upl	upl	5 UPL	Fabaceae
MEDICAGO POLYMORPHA	FACU	FACU	FACU	3 FACU	Fabaceae
MEDICAGO SATIVA	UPL	UPL	FACU	5 UPL	Fabaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
MELAMPODIUM CINEREUM var. RAMOSISSIMUM	upl	upl	upl	5	UPL	Asteraceae
Melanthium virginicum	OBL	FACW	FACW	-3	FACW	Liliaceae
MELIA AZEDARACH	UPL	UPL	FACU	5	UPL	Meliaceae
Melica mutica	upl	upl	upl	5	UPL	Poaceae
Melica nitens	upl	upl	upl	5	UPL	Poaceae
MELILOTUS ALBUS	FACU	FACU	FACU	3	FACU	Fabaceae
MELILOTUS OFFICINALE	FACU	FACU	FACU	3	FACU	Fabaceae
MELISSA OFFICINALIS	UPL	UPL	UPL	5	UPL	Lamiaceae
MELOCHIA CORCHORIFOLIA	FAC	FAC	FACU	3	FACU	Malvaceae
Melothria pendula	FAC	FAC	FAC	0	FAC	Cucurbitaceae
Menispermum canadense	FACU	FACU	FAC	3	FACU	Menispermaceae
MENTHA × GRACILIS	FAC	FACW	OBL	-3	FACW	Lamiaceae
MENTHA × PIPERITA	FACW	FACW	OBL	-3	FACW	Lamiaceae
MENTHA AQUATICA var. CITRATA	OBL	FACW	OBL	-5	OBL	Lamiaceae
Mentha canadensis	FACW	FACW	FACW	-3	FACW	Lamiaceae
MENTHA LONGIFOLIA	FACW	FACW	FACW	-3	FACW	Lamiaceae
MENTHA SPICATA	FACW	FACW	FACW	-3	FACW	Lamiaceae
MENTZELIA ALBESCENS	upl	upl	upl	5	UPL	Loasaceae
MENTZELIA NUDA	upl	upl	upl	5	UPL	Loasaceae
Mentzelia oligosperma	upl	upl	upl	5	UPL	Loasaceae
Menyanthes trifoliata	OBL	OBL	OBL	-5	OBL	Menyanthaceae
Mertensia virginica	FAC	FACW	FACW	0	FAC	Boraginaceae
Micranthes pensylvanica var. forbesii	OBL	OBL	OBL	0	[FAC]	Saxifragaceae
Micranthes texana	FAC	FAC	FAC	5	[UPL]	Saxifragaceae
Micranthes virginiensis	FAC	FAC	FACU	3	FACU	Saxifragaceae
MICROSTEGIUM VIMINEUM	FAC	FAC	FAC	0	FAC	Poaceae
MICROTHLASPI PERFOLIATUM	upl	upl	upl	5	UPL	Brassicaceae
Mikania scandens	FACW	FACW	OBL	-5	OBL	Asteraceae
Mimosa quadrivalvis var. nuttallii	upl	upl	upl	5	UPL	Fabaceae
Mimulus alatus	OBL	OBL	OBL	-5	OBL	Phrymaceae
Mimulus glabratus	OBL	OBL	OBL	-5	OBL	Phrymaceae
Mimulus ringens	OBL	OBL	OBL	-5	OBL	Phrymaceae
Minuartia michauxii	upl	upl	upl	5	UPL	Caryophyllaceae
Minuartia muscorum	FACU	FACU	FACU	3	FACU	Caryophyllaceae
Minuartia patula	FAC	UPL	FACU	5	UPL	Caryophyllaceae
Mirabilis albida	upl	upl	upl	5	UPL	Nyctaginaceae
Mirabilis linearis	UPL	UPL	UPL	5	UPL	Nyctaginaceae
Mirabilis nyctaginea	FACU	FACU	UPL	3	FACU	Nyctaginaceae
MISCANTHUS SACCHARIFLORUS	upl	upl	upl	5	UPL	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
MISCANTHUS SINENSIS	UPL	FACU	UPL	5	UPL	Poaceae
Mitchella repens	FACU	FACU	FACU	3	FACU	Rubiaceae
Mitella diphylla	FACU	FACU	FACU	3	FACU	Saxifragaceae
Mitreola petiolata	FACW	FACW	facw	-3	FACW	Loganiaceae
Moehringia lateriflora	FAC	FAC	FACU	3	FACU	Caryophyllaceae
MOLLUGO VERTICILLATA	FAC	FAC	FAC	0	FAC	Molluginaceae
Monarda bradburiana	upl	upl	upl	5	UPL	Lamiaceae
Monarda citriodora	upl	upl	upl	5	UPL	Lamiaceae
Monarda clinopodia	FACU	FACU	FACU	3	FACU	Lamiaceae
MONARDA DIDYMA	FAC	FAC	UPL	3	FACU	Lamiaceae
Monarda fistulosa	FACU	UPL	FACU	3	FACU	Lamiaceae
MONARDA PECTINATA	upl	upl	upl	5	UPL	Lamiaceae
Monarda punctata var. arkansana	FACU	UPL	UPL	5	UPL	Lamiaceae
MONARDA PUNCTATA var. OCCIDENTALIS	FACU	UPL	UPL	5	UPL	Lamiaceae
Monarda punctata var. villicaulis	FACU	UPL	UPL	5	UPL	Lamiaceae
MONOLEPIS NUTTALLIANA	FACU	UPL	UPL	5	UPL	Chenopodiaceae
Monotropa hypopitys	upl	upl	upl	5	UPL	Ericaceae
Monotropa uniflora	FACU	FACU	FACU	3	FACU	Ericaceae
MORUS ALBA	FACU	UPL	FAC	3	FACU	Moraceae
Morus rubra	FACU	FACU	FACU	3	FACU	Moraceae
Muhlenbergia asperifolia	FACW	FACW	FACW	-3	FACW	Poaceae
Muhlenbergia bushii	upl	upl	upl	5	UPL	Poaceae
Muhlenbergia capillaris	FAC	FACU	FACU	3	FACU	Poaceae
Muhlenbergia cuspidata	upl	upl	upl	5	UPL	Poaceae
Muhlenbergia frondosa	FAC	FAC	FACW	0	FAC	Poaceae
Muhlenbergia glabrifloris	FAC	FAC	FACU	5	UPL	Poaceae
Muhlenbergia mexicana	FAC	FACW	FACW	0	FAC	Poaceae
Muhlenbergia racemosa	FACW	FAC	FACW	-3	FACW	Poaceae
Muhlenbergia schreberi	FAC	FAC	FAC	0	FAC	Poaceae
Muhlenbergia sobolifera	upl	upl	upl	5	UPL	Poaceae
Muhlenbergia sylvatica	FACW	FAC	FACW	-3	FACW	Poaceae
Muhlenbergia tenuiflora	FACU	FACU	FACU	3	FACU	Poaceae
MUSCARI BOTRYOIDES	upl	upl	upl	5	UPL	Liliaceae
MUSCARI COMOSUM	upl	upl	upl	5	UPL	Liliaceae
MUSCARIA RACEMOSUM	upl	upl	upl	5	UPL	Liliaceae
Myosotis macrosperma	FAC	FAC	FAC	0	FAC	Boraginaceae
MYOSOTIS SCORPIOIDES	OBL	OBL	OBL	-5	OBL	Boraginaceae
MYOSOTIS STRICTA	UPL	UPL	UPL	5	UPL	Boraginaceae
Myosotis verna	FACU	FAC	FACU	3	FACU	Boraginaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
MYOSOTON AQUATICUM	FACW	FACW	FACW	-3	FACW	Caryophyllaceae
Myosurus minimus	FACW	FACW	FACW	-3	FACW	Ranunculaceae
MYRIOPHYLLUM AQUATICUM	OBL	OBL	OBL	-5	OBL	Haloragaceae
Myriophyllum heterophyllum	OBL	OBL	OBL	-5	OBL	Haloragaceae
Myriophyllum pinnatum	OBL	OBL	OBL	-5	OBL	Haloragaceae
MYRIOPHYLLUM SIBIRICUM	OBL	OBL	OBL	-5	OBL	Haloragaceae
MYRIOPHYLLUM SPICATUM	OBL	OBL	OBL	-5	OBL	Haloragaceae
Najas flexilis	OBL	OBL	OBL	-5	OBL	Najadaceae
Najas gracillima	OBL	OBL	OBL	-5	OBL	Najadaceae
Najas guadalupensis	OBL	OBL	OBL	-5	OBL	Najadaceae
NAJAS MINOR	OBL	OBL	OBL	-5	OBL	Najadaceae
NARCISSUS POETICUS	upl	upl	upl	5	UPL	Liliaceae
NARCISSUS PSEUDO-NARCISSUS	upl	upl	upl	5	UPL	Liliaceae
NASTURTIUM OFFICINALE	OBL	OBL	OBL	-5	OBL	Brassicaceae
Nelumbo lutea	OBL	OBL	OBL	-5	OBL	Nelumbonaceae
NELUMBO NUCIFERA	OBL	OBL	OBL	-5	OBL	Nelumbonaceae
Nemastylis geminiflora	upl	upl	upl	5	UPL	Iridaceae
Nemastylis nuttallii	upl	upl	upl	5	UPL	Iridaceae
NEPETA CATARIA	FACU	FACU	FACU	3	FACU	Lamiaceae
NESLIA PANICULATA	upl	upl	upl	5	UPL	Brassicaceae
Neviusia alabamensis	upl	upl	upl	5	UPL	Rosaceae
NICANDRA PHYSALODES	upl	upl	upl	5	UPL	Solanaceae
NICOTIANA LONGIFLORA	upl	upl	upl	5	UPL	Solanaceae
NICOTIANA RUSTICA	upl	upl	upl	5	UPL	Solanaceae
NICOTIANA TABACUM	UPL	UPL	FACU	5	UPL	Solanaceae
Nothocalis cuspidata	upl	upl	upl	5	UPL	Asteraceae
Nothoscordum bivalve	FACU	FACU	FACU	3	FACU	Liliaceae
Nuphar advena subsp. advena	OBL	OBL	OBL	-5	OBL	Nymphaeaceae
Nuphar advena subsp. ozarkana	OBL	OBL	OBL	-5	OBL	Nymphaeaceae
Nuttallanthus canadensis	upl	upl	upl	5	UPL	Plantaginaceae
Nuttallanthus texanus	upl	upl	upl	5	UPL	Plantaginaceae
Nymphaea odorata	OBL	OBL	OBL	-5	OBL	Nymphaeaceae
NYMPHOIDES PELTATA	OBL	OBL	OBL	-5	OBL	Menyanthaceae
Nyssa aquatica	OBL	OBL	OBL	-5	OBL	Cornaceae
Nyssa biflora	OBL	FACW	obl	-3	FACW	Cornaceae
Nyssa sylvatica	FAC	FAC	FAC	0	FAC	Cornaceae
Obolaria virginica	upl	upl	upl	5	UPL	Gentianaceae
OCIMUM BASILICUM	FACU	UPL	FACU	5	UPL	Lamiaceae
OENANTHE JAVANICA	OBL	OBL	OBL	-5	OBL	Apiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Oenothera biennis	FACU	FACU	FACU	3	FACU	Onagraceae
Oenothera clelandii	UPL	UPL	UPL	5	UPL	Onagraceae
Oenothera fruticosa subsp. fruticosa	FACU	FAC	FACU	3	FACU	Onagraceae
Oenothera fruticosa subsp. glauca	FACU	FAC	FACU	3	FACU	Onagraceae
Oenothera grandis	upl	upl	upl	5	UPL	Onagraceae
OENOTHERA HETEROPHYLLA	upl	upl	upl	5	UPL	Onagraceae
Oenothera laciniata	FACU	FACU	FACU	3	FACU	Onagraceae
Oenothera linifolia	upl	upl	upl	5	UPL	Onagraceae
Oenothera macrocarpa	upl	upl	upl	5	UPL	Onagraceae
Oenothera nutans	upl	upl	upl	5	UPL	Onagraceae
Oenothera parviflora	FACU	FACU	FACU	3	FACU	Onagraceae
Oenothera perennis	FAC	FAC	FAC	0	FAC	Onagraceae
Oenothera pilosella	FACU	FAC	FAC	0	FAC	Onagraceae
Oenothera rhombipetala	FACU	FACU	FACU	3	FACU	Onagraceae
Oenothera speciosa	upl	upl	upl	5	UPL	Onagraceae
Oenothera triloba	upl	upl	upl	5	UPL	Onagraceae
Oenothera villosa	FACU	FAC	FAC	3	FACU	Onagraceae
Oldenlandia boscii	FACW	FACW	OBL	-3	FACW	Rubiaceae
Oldenlandia uniflora	FACW	FACW	FACW	-3	FACW	Rubiaceae
Oligoneuron album	upl	upl	upl	5	UPL	Asteraceae
Oligoneuron riddellii	OBL	OBL	OBL	-5	OBL	Asteraceae
Oligoneuron rigidum	FACU	UPL	FACU	3	FACU	Asteraceae
Onoclea sensibilis	FACW	FACW	FACW	-3	FACW	Dryopteridaceae
ONOPORDUM ACANTHIUM	upl	upl	upl	5	UPL	Asteraceae
Onosmodium molle subsp. hispidissimum	upl	upl	upl	5	UPL	Boraginaceae
Onosmodium molle subsp. occidentale	upl	upl	upl	5	UPL	Boraginaceae
Onosmodium molle subsp. subsetosum	upl	upl	upl	5	UPL	Boraginaceae
Ophioglossum crotalophoroides	FAC	FAC	UPL	3	FACU	Ophioglossaceae
Ophioglossum engelmannii	FACU	FACU	FACU	3	FACU	Ophioglossaceae
Ophioglossum petiolatum	FAC	FAC	fac	0	FAC	Ophioglossaceae
Ophioglossum vulgatum	FACW	FACW	FACW	-3	FACW	Ophioglossaceae
Opuntia humifusa	upl	upl	upl	5	UPL	Cactaceae
Opuntia macrorhiza	upl	upl	upl	5	UPL	Cactaceae
Opuntia polyacantha	upl	upl	upl	5	UPL	Cactaceae
Orbexilum onobrychis	upl	upl	upl	5	UPL	Fabaceae
Orbexilum pedunculatum	FACU	FACU	FACU	3	FACU	Fabaceae
ORIGANUM VULGARE	upl	upl	upl	5	UPL	Lamiaceae
ORNITHOGALUM NUTANS	upl	upl	upl	5	UPL	Liliaceae
ORNITHOGALUM UMBELLATUM	FACU	FACU	FACU	3	FACU	Liliaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO	FAMILY
Orobanche ludoviciana	upl	upl	upl	5 UPL	Orobanchaceae
Orobanche riparia	[facw]	[facw]	[facw]	-3 [FACW]	Orobanchaceae
Orobanche uniflora	FACU	FACU	UPL	3 FACU	Orobanchaceae
ORYZA SATIVA	OBL	OBL	OBL	-5 OBL	Poaceae
Oryzopsis racemosa	upl	upl	upl	5 UPL	Poaceae
Osmorhiza claytonii	FACU	FACU	FACU	3 FACU	Apiaceae
Osmorhiza longistylis	FAC	FACU	FACU	3 FACU	Apiaceae
Osmunda cinnamomea	FACW	FACW	FACW	-3 FACW	Osmundaceae
Osmunda claytoniana	FAC	FAC	FAC	0 FAC	Osmundaceae
Osmunda regalis var. spectabilis	OBL	OBL	OBL	-5 OBL	Osmundaceae
Ostrya virginiana	FACU	FACU	FACU	3 FACU	Betulaceae
OTTELIA ALISMOIDES	OBL	OBL	obl	-5 OBL	Hydrocharitaceae
OXALIS CORNICULATA	UPL	FACU	FACU	3 FACU	Oxalidaceae
Oxalis dillenii	FACU	FACU	FACU	3 FACU	Oxalidaceae
Oxalis florida	FACU	FACU	FACU	-3 [FACW]	Oxalidaceae
Oxalis stricta	UPL	FACU	FACU	3 FACU	Oxalidaceae
Oxalis violacea	upl	upl	upl	5 UPL	Oxalidaceae
Oxypolis rigidior	OBL	OBL	OBL	-5 OBL	Apiaceae
Oxytropis lambertii	FACU	FACU	FACU	3 FACU	Fabaceae
PACHYSANDRA PROCUMBENS	upl	upl	upl	5 UPL	Buxaceae
Packera aurea	FACW	FACW	FACW	-3 FACW	Asteraceae
Packera glabella	OBL	OBL	FACW	-3 FACW	Asteraceae
Packera obovata	FACU	FACU	FACU	3 FACU	Asteraceae
Packera paupercula	FACW	FAC	FAC	0 FAC	Asteraceae
Packera plattensis	FACU	FACU	FACU	3 FACU	Asteraceae
Packera pseudaurea var. semicordata	facw	FACW	FACW	-3 FACW	Asteraceae
Packera tomentosa	FACU	FACU	facu	3 FACU	Asteraceae
Palafoxia callosa	upl	upl	upl	5 UPL	Asteraceae
Panax quinquefolius	upl	upl	upl	5 UPL	Araliaceae
Panicum anceps	FAC	FAC	FACW	0 FAC	Poaceae
Panicum capillare	FAC	FAC	FAC	0 FAC	Poaceae
Panicum dichotomiflorum	FACW	FACW	FACW	-3 FACW	Poaceae
Panicum flexile	FAC	FACU	FACW	3 FACU	Poaceae
Panicum gattingeri	FAC	FAC	FAC	0 FAC	Poaceae
Panicum longifolium	FACW	FACW	FACW	-5 [OBL]	Poaceae
PANICUM MILIACEUM	upl	upl	upl	5 UPL	Poaceae
PANICUM OBTUSUM	FACW	FACW	FACW	-3 FACW	Poaceae
Panicum philadelphicum	FAC	FAC	FACW	0 FAC	Poaceae
Panicum rigidulum	FACW	FACW	FACW	-3 FACW	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO	FAMILY
Panicum verrucosum	FACW	FACW	FACW	-3 FACW	Poaceae
Panicum virgatum	FAC	FAC	FAC	0 FAC	Poaceae
PAPAVER DUBIUM	upl	upl	upl	5 UPL	Papaveraceae
PAPAVER RHOEAS	upl	upl	upl	5 UPL	Papaveraceae
PAPAVER SOMNIFERUM	upl	upl	upl	5 UPL	Papaveraceae
Parietaria pensylvanica	FACU	FACU	FACU	3 FACU	Urticaceae
Parnassia grandifolia	OBL	OBL	obl	-5 OBL	Parnassiaceae
Paronychia canadensis	upl	upl	upl	5 UPL	Caryophyllaceae
Paronychia fastigiata	upl	upl	upl	5 UPL	Caryophyllaceae
Paronychia virginica	upl	upl	upl	5 UPL	Caryophyllaceae
Parthenium hispidum	upl	upl	upl	5 UPL	Asteraceae
PARTHENIUM HYSTEROPHORUS	FAC	FAC	FAC	0 FAC	Asteraceae
Parthenium integrifolium	upl	upl	upl	5 UPL	Asteraceae
Parthenocissus quinquefolia	FACU	FACU	FACU	3 FACU	Vitaceae
PARTHENOCISSUS TRICUSPIDATA	upl	upl	upl	5 UPL	Vitaceae
Parthenocissus vitacea	FACU	FACU	FACU	3 FACU	Vitaceae
Pascopyrum smithii	FACU	UPL	FACU	5 UPL	Poaceae
PASPALIDIUM GEMINATUM	OBL	OBL	OBL	-5 OBL	Poaceae
Paspalum bifidum	FACW	FACW	FACW	-3 FACW	Poaceae
PASPALUM DILATATUM	FAC	FAC	FAC	0 FAC	Poaceae
Paspalum dissectum	OBL	OBL	OBL	-5 OBL	Poaceae
PASPALUM DISTICHUM	OBL	FACW	OBL	-5 OBL	Poaceae
Paspalum floridanum	FACW	FACW	FACW	-3 FACW	Poaceae
Paspalum laeve var. circulare	FACW	FAC	FACW	0 FAC	Poaceae
Paspalum laeve var. laeve	FACW	FAC	FACW	0 FAC	Poaceae
Paspalum pubiflorum	FACW	FAC	FACW	0 FAC	Poaceae
Paspalum repens	OBL	OBL	OBL	-5 OBL	Poaceae
Paspalum setaceum var. ciliatifolium	FAC	FACU	FACU	3 FACU	Poaceae
Paspalum setaceum var. muhlenbergii	FAC	FACU	FACU	3 FACU	Poaceae
Paspalum setaceum var. setaceum	FAC	FACU	FACU	3 FACU	Poaceae
Paspalum setaceum var. stramineum	FAC	FACU	FACU	3 FACU	Poaceae
PASPALUM URVILLEI	FAC	FAC	FAC	0 FAC	Poaceae
Passiflora incarnata	upl	upl	upl	5 UPL	Passifloraceae
Passiflora lutea	upl	upl	upl	5 UPL	Passifloraceae
PASTINACA SATIVA	upl	upl	upl	5 UPL	Apiaceae
PAULOWNIA TOMENTOSA	UPL	UPL	UPL	5 UPL	Paulowniaceae
Pedicularis canadensis	FACU	FACU	FACU	3 FACU	Orobanchaceae
Pedicularis lanceolata	FACW	FACW	OBL	-5 OBL	Orobanchaceae
Pediomelum argophyllum	upl	upl	upl	5 UPL	Fabaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Pediomelum esculentum	upl	upl	upl	5	UPL	Fabaceae
Pediomelum tenuiflorum	upl	upl	upl	5	UPL	Fabaceae
Pellaea × gastonyi	upl	upl	upl	5	UPL	Pteridaceae
Pellaea atropurpurea	upl	upl	upl	5	UPL	Pteridaceae
Pellaea glabella	upl	upl	upl	5	UPL	Pteridaceae
Peltandra virginica	OBL	OBL	OBL	-5	OBL	Araceae
PENNISETUM ALOPECUROIDES	upl	upl	upl	5	UPL	Poaceae
PENNISETUM AMERICANUM	upl	upl	upl	5	UPL	Poaceae
PENNISETUM SETACEUM	upl	upl	upl	5	UPL	Poaceae
Penstemon arkansanus	upl	upl	upl	5	UPL	Plantaginaceae
Penstemon cobaea var. cobaea	upl	upl	upl	5	UPL	Plantaginaceae
Penstemon cobaea var. purpureus	upl	upl	upl	5	UPL	Plantaginaceae
Penstemon digitalis	FAC	FAC	FAC	0	FAC	Plantaginaceae
Penstemon grandiflorus	upl	upl	upl	5	UPL	Plantaginaceae
Penstemon pallidus	FACU	FACU	UPL	5	UPL	Plantaginaceae
Penstemon tenuis	FACW	FACW	[facu]	3	[FACU]	Plantaginaceae
Penstemon tubaeflorus	upl	upl	upl	5	UPL	Plantaginaceae
Penthorum sedoides	OBL	OBL	OBL	-5	OBL	Penthoraceae
Perideridia americana	upl	upl	upl	5	UPL	Apiaceae
PERILLA FRUTESCENS	FACU	fac	FAC	0	FAC	Lamiaceae
Persicaria amphibia var. emersa	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria amphibia var. stipulacea	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria arifolia	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria bicornis	FACW	FACW	FACW	-3	FACW	Polygonaceae
Persicaria glabra	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria hydropiper	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria hydropiperoides	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria lapathifolia	FACW	FACW	FACW	0	[FAC]	Polygonaceae
PERSICARIA LONGISETA	FAC	facu	FAC	3	[FACU]	Polygonaceae
PERSICARIA MACULOSA	FACW	FACW	FACW	-3	FACW	Polygonaceae
PERSICARIA ORIENTALIS	FAC	FACU	UPL	3	FACU	Polygonaceae
Persicaria pensylvanica	FACW	FACW	FACW	-3	FACW	Polygonaceae
Persicaria punctata	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria robustior	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria sagittata	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria setacea	OBL	OBL	OBL	-5	OBL	Polygonaceae
Persicaria virginiana	FAC	FAC	FAC	0	FAC	Polygonaceae
PETROHAGIA PROLIFERA	upl	upl	upl	5	UPL	Caryophyllaceae
PETUNIA × ATKINSIANA	upl	upl	upl	5	UPL	Solanaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
PETUNIA AXILLARIS	upl	upl	upl	5	UPL	Solanaceae
PETUNIA INTEGRIFOLIA	upl	upl	upl	5	UPL	Solanaceae
Phacelia bipinnatifida	upl	upl	upl	5	UPL	Hydrophyllaceae
Phacelia covillei	FACW	FACW	FACW	-3	FACW	Hydrophyllaceae
Phacelia gilioides	upl	upl	upl	5	UPL	Hydrophyllaceae
Phacelia hirsuta	upl	upl	upl	5	UPL	Hydrophyllaceae
Phacelia purshii	upl	upl	upl	5	UPL	Hydrophyllaceae
Phacelia ranunculacea	FACW	FACW	FACW	-3	FACW	Hydrophyllaceae
PHALARIS ARUNDINACEA	OBL	FACW	FACW	-3	FACW	Poaceae
PHALARIS BRACHYSTACHYS	FACW	FACW	facw	-3	FACW	Poaceae
PHALARIS CANARIENSIS	FACU	FACU	FACU	3	FACU	Poaceae
Phalaris caroliniana	FACW	FACW	FACW	-3	FACW	Poaceae
PHASEOLUS LUNATUS	upl	upl	upl	5	UPL	Fabaceae
Phaseolus polystachios	upl	upl	upl	5	UPL	Fabaceae
PHASEOLUS VULGARIS	upl	upl	upl	5	UPL	Fabaceae
Phegoteris hexagonoptera	FACU	FAC	FACU	3	FACU	Thelypteridaceae
PHELLODENDRON AMURENSE	upl	upl	upl	5	UPL	Rutaceae
Phemeranthus calycinus	upl	upl	upl	5	UPL	Portulacaceae
Phemeranthus parviflorus	upl	upl	upl	5	UPL	Portulacaceae
PHILADELPHUS CORONARIUS	upl	upl	upl	5	UPL	Hydrangeaceae
Philadelphus pubescens var. verrucosus	upl	upl	upl	5	UPL	Hydrangeaceae
PHLEUM PRATENSE	FACU	FACU	FACU	3	FACU	Poaceae
Phlox amplifolia	upl	upl	upl	5	UPL	Polemoniaceae
Phlox bifida	upl	upl	upl	5	UPL	Polemoniaceae
Phlox divaricata	FACU	FACU	FACU	3	FACU	Polemoniaceae
PHLOX DRUMMONDII	upl	upl	upl	5	UPL	Polemoniaceae
Phlox glaberrima subsp. interior	FACW	FAC	FACW	-3	FACW	Polemoniaceae
Phlox maculata subsp. pyramidalis	FAC	FACW	FACW	-3	FACW	Polemoniaceae
Phlox paniculata	FACU	FACU	FACU	3	FACU	Polemoniaceae
Phlox pilosa subsp. fulgida	FACU	FACU	FACU	3	FACU	Polemoniaceae
Phlox pilosa subsp. ozarkana	FACU	FACU	FACU	3	FACU	Polemoniaceae
Phlox pilosa subsp. pilosa	FACU	FACU	FACU	3	FACU	Polemoniaceae
PHLOX SUBULATA	upl	upl	upl	5	UPL	Polemoniaceae
Phoradendron leucarpum	upl	upl	upl	5	UPL	Viscaceae
Phragmites australis subsp. americanus	FACW	FACW	FACW	-3	FACW	Poaceae
PHRAGMITES AUSTRALIS subsp. AUSTRALIS	FACW	FACW	FACW	-3	FACW	Poaceae
Phryma leptostachya	FACU	FACU	UPL	5	UPL	Phrymaceae
Phyllanthus carolinensis	FAC	FAC	FAC	0	FAC	Euphorbiaceae
Phyllanthus polygonoides	upl	upl	upl	5	UPL	Euphorbiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
PHYLLOSTACHYS VIRIDIS	upl	upl	upl	5	UPL	Poaceae
PHYSALIS ACUTIFOLIA	upl	upl	upl	5	UPL	Solanaceae
PHYSALIS ALKEKENGI	upl	upl	upl	5	UPL	Solanaceae
Physalis angulata	FACU	FAC	FAC	3	FACU	Solanaceae
PHYSALIS CINERASCENS	upl	upl	upl	5	UPL	Solanaceae
Physalis cordata	upl	upl	upl	5	UPL	Solanaceae
Physalis grisea	upl	upl	upl	5	UPL	Solanaceae
Physalis heterophylla	upl	upl	upl	5	UPL	Solanaceae
Physalis longifolia	upl	upl	upl	5	UPL	Solanaceae
Physalis missouriensis	upl	upl	upl	5	UPL	Solanaceae
PHYSALIS PHILADELPHICA	UPL	UPL	UPL	5	UPL	Solanaceae
Physalis pubescens	UPL	FACU	UPL	5	UPL	Solanaceae
Physalis pumila	upl	upl	upl	5	UPL	Solanaceae
Physalis virginiana	upl	upl	upl	5	UPL	Solanaceae
Physaria filiformis	upl	upl	upl	5	UPL	Brassicaceae
PHYSARIA GRACILIS	FACW	UPL	UPL	5	UPL	Brassicaceae
Physocarpus opulifolius var. intermedius	FAC	FACW	FACW	-3	FACW	Rosaceae
Physostegia angustifolia	FACW	FACW	FAC	-3	FACW	Lamiaceae
Physostegia intermedia	FACW	FACW	FACW	-3	FACW	Lamiaceae
Physostegia virginiana subsp. praemorsa	FACW	FAC	FACW	-3	FACW	Lamiaceae
Physostegia virginiana subsp. virginiana	FACW	FAC	FACW	-3	FACW	Lamiaceae
Phytolacca americana	FACU	FACU	FACU	3	FACU	Phytolaccaceae
PICRIS HIERACIOIDES	upl	upl	upl	5	UPL	Asteraceae
PICRIS RHAGADIOLOIDES	upl	upl	upl	5	UPL	Asteraceae
Pilea pumila	FACW	FACW	FACW	-3	FACW	Urticaceae
Pilularia americana	OBL	OBL	OBL	-5	OBL	Marsileaceae
PINUS BANKSIANA	facu	FACU	FACU	3	FACU	Pinaceae
Pinus echinata	upl	upl	upl	5	UPL	Pinaceae
PINUS NIGRA	upl	upl	upl	5	UPL	Pinaceae
PINUS STROBUS	FACU	FACU	FACU	3	FACU	Pinaceae
PINUS TAEDA	FAC	FAC	UPL	3	FACU	Pinaceae
PINUS VIRGINIANA	upl	upl	upl	5	UPL	Pinaceae
PISTIA STRATIOTES	OBL	OBL	OBL	-5	OBL	Araceae
PISUM SATIVUM	upl	upl	upl	5	UPL	Fabaceae
Planera aquatica	OBL	OBL	OBL	-5	OBL	Ulmaceae
Planodes virginica	FACU	UPL	FACU	3	FACU	Brassicaceae
Plantago aristata	upl	upl	upl	5	UPL	Plantaginaceae
Plantago cordata	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Plantago elongata	FACU	UPL	FACU	3	FACU	Plantaginaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Plantago heterophylla	FACW	FAC	FACW	-3	FACW	Plantaginaceae
PLANTAGO INDICA	FACU	FACU	FACU	3	FACU	Plantaginaceae
PLANTAGO LANCEOLATA	FACU	UPL	FACU	3	FACU	Plantaginaceae
PLANTAGO MAJOR	FAC	FACU	FAC	3	FACU	Plantaginaceae
Plantago patagonica	UPL	UPL	UPL	5	UPL	Plantaginaceae
PLANTAGO RHODOSPERMA	UPL	UPL	FACU	5	UPL	Plantaginaceae
Plantago rugelii	FACU	FACU	FAC	0	FAC	Plantaginaceae
Plantago virginica	FACU	UPL	FACU	5	UPL	Plantaginaceae
PLANTAGO WRIGHTIANA	upl	upl	upl	5	UPL	Plantaginaceae
Platanthera ciliaris	FACW	FACW	FACW	-3	FACW	Orchidaceae
Platanthera clavellata	OBL	FACW	OBL	-5	OBL	Orchidaceae
Platanthera flava var. flava	FACW	FACW	FACW	-3	FACW	Orchidaceae
Platanthera flava var. herbiola	FACW	FACW	FACW	-3	FACW	Orchidaceae
Platanthera lacera	FACW	FACW	FACW	-3	FACW	Orchidaceae
Platanthera leucophaea	OBL	FACW	FACW	-3	FACW	Orchidaceae
Platanthera peramoena	FACW	FACW	FACW	-3	FACW	Orchidaceae
Platanthera praeclara	[facu]	[facu]	[facu]	3	[FACU]	Orchidaceae
Platanthera psychodes	FACW	FACW	FACW	-3	FACW	Orchidaceae
Platanus occidentalis	FACW	FACW	FACW	-3	FACW	Platanaceae
Pluchea camphorata	FACW	FACW	FACW	-3	FACW	Asteraceae
Pluchea foetida	OBL	OBL	obl	-5	OBL	Asteraceae
POA ANNUA	FACU	FACU	FACU	3	FACU	Poaceae
POA BULBOSA	FACU	FACU	FACU	3	FACU	Poaceae
Poa chapmaniana	FAC	UPL	FACU	3	FACU	Poaceae
POA COMPRESSA	FACU	FACU	FACU	3	FACU	Poaceae
Poa interior	fac	FAC	FAC	5	[UPL]	Poaceae
POA PALUSTRIS	FAC	FACW	FACW	-3	FACW	Poaceae
POA PRATENSIS	FACU	FACU	FAC	3	FACU	Poaceae
Poa sylvestris	FACW	FACW	FAC	0	FAC	Poaceae
POA TRIVIALIS	FACW	FACW	FACW	-3	FACW	Poaceae
Poa wolfii	upl	upl	upl	5	UPL	Poaceae
Podophyllum peltatum	FACU	FACU	FACU	3	FACU	Berberidaceae
Pogonia ophioglossoides	OBL	OBL	OBL	-5	OBL	Orchidaceae
Polanisia dodecandra subsp. dodecandra	FACU	FACU	UPL	5	UPL	Cleomaceae
Polanisia dodecandra subsp. trachysperma	FACU	FACU	UPL	5	UPL	Cleomaceae
Polemonium reptans	FAC	FACU	FAC	3	FACU	Polemoniaceae
Polygala incarnata	FAC	FACU	FACU	3	FACU	Polygalaceae
Polygala sanguinea	FAC	FAC	FACU	3	FACU	Polygalaceae
Polygala senega	FACU	FACU	FACU	3	FACU	Polygalaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Polygala verticillata	UPL	UPL	UPL	5	UPL	Polygalaceae
Polygonatum biflorum var. commutatum	FACU	FACU	FACU	3	FACU	Liliaceae
Polygonum achoreum	FAC	FACU	FAC	3	FACU	Polygonaceae
Polygonum americanum	upl	upl	upl	5	UPL	Polygonaceae
POLYGONUM AVICULARE subsp. AVICULARE	FAC	FACU	FAC	3	FACU	Polygonaceae
Polygonum aviculare subsp. buxiforme	FAC	FACU	FAC	5	[UPL]	Polygonaceae
POLYGONUM AVICULARE subsp. DEPRESSUM	FAC	FACU	FAC	3	FACU	Polygonaceae
POLYGONUM AVICULARE subsp. NEGLECTUM	FAC	FACU	FAC	5	[UPL]	Polygonaceae
Polygonum erectum	FACU	FACU	FACU	3	FACU	Polygonaceae
Polygonum ramosissimum var. prolificum	FACU	FAC	FACU	3	FACU	Polygonaceae
Polygonum ramosissimum var. ramosissimum	FACU	FAC	FACU	3	FACU	Polygonaceae
Polygonum tenue	upl	upl	upl	5	UPL	Polygonaceae
Polymnia canadensis	upl	upl	upl	5	UPL	Asteraceae
Polymnia laevigata	upl	upl	upl	5	UPL	Asteraceae
Polypodium polypodioides var. michauxianum	FAC	FACU	FACU	0	FAC	Polypodiaceae
Polypodium virginianum	upl	upl	upl	5	UPL	Polypodiaceae
Polypremum procumbens	upl	upl	upl	5	UPL	Tetrachondraceae
Polystichum acrostichoides	FACU	FACU	UPL	3	FACU	Dryopteridaceae
Polytaenia nuttallii	upl	upl	upl	5	UPL	Apiaceae
POMARIA JAMESII	upl	upl	upl	5	UPL	Fabaceae
Pontederia cordata	OBL	OBL	OBL	-5	OBL	Pontederiaceae
POPULUS × CANADENSIS	upl	upl	upl	5	UPL	Salicaceae
POPULUS × CANESCENS	upl	upl	upl	5	UPL	Salicaceae
POPULUS × JACKII	upl	upl	upl	5	UPL	Salicaceae
POPULUS ALBA	upl	upl	upl	5	UPL	Salicaceae
Populus deltoides	FAC	FAC	FAC	0	FAC	Salicaceae
Populus grandidentata	FACU	FACU	FACU	3	FACU	Salicaceae
Populus heterophylla	OBL	OBL	OBL	-5	OBL	Salicaceae
POPULUS NIGRA var. ITALICA	upl	upl	upl	5	UPL	Salicaceae
Populus tremuloides	FAC	FAC	FAC	0	FAC	Salicaceae
PORTULACA GRANDIFLORA	UPL	UPL	FACU	5	UPL	Portulacaceae
Portulaca pilosa	FACU	FACU	FACU	5	[UPL]	Portulacaceae
Portulacca oleracea	FACU	FAC	FACU	3	FACU	Portulacaceae
Potamogeton amplifolius	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
POTAMOGETON CRISPUS	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
Potamogeton diversifolius	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
Potamogeton epihydrus	OBL	OBL	OBL	-5	OBL	Potamogetonaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Potamogeton foliosus	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
Potamogeton illinoensis	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
Potamogeton nodosus	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
Potamogeton pectinatus	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
Potamogeton pulcher	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
Potamogeton pusillus	OBL	OBL	OBL	-5	OBL	Potamogetonaceae
POTENTILLA ARGENTEA	FACU	UPL	FACU	3	FACU	Rosaceae
Potentilla canadensis	upl	upl	upl	5	UPL	Rosaceae
Potentilla norvegica	FAC	FACU	FAC	3	FACU	Rosaceae
POTENTILLA RECTA	upl	upl	upl	5	UPL	Rosaceae
Potentilla rivalis	FACW	FACW	FACW	-3	FACW	Rosaceae
Potentilla simplex	FACU	FACU	FACU	3	FACU	Rosaceae
Potentilla supina subsp. paradoxa	FACW	OBL	FACW	-3	FACW	Rosaceae
Prenanthes alba	FACU	FACU	FACU	3	FACU	Asteraceae
Prenanthes altissima	UPL	FACU	FACU	3	FACU	Asteraceae
Prenanthes aspera	UPL	UPL	UPL	5	UPL	Asteraceae
Prenanthes crepidinea	UPL	FACU	FAC	3	FACU	Asteraceae
Prenanthes racemosa	FACW	FACW	FACW	-3	FACW	Asteraceae
Primula fassettii	upl	upl	upl	5	UPL	Primulaceae
Primula frenchii	upl	upl	upl	5	UPL	Primulaceae
Primula meadia	FACU	FACU	FACU	3	FACU	Primulaceae
PRIMULA VERIS	upl	upl	upl	5	UPL	Primulaceae
PROBOSCIDEA LOUISIANA	FACU	FACU	FAC	3	FACU	Martyniaceae
Proserpinaca palustris	OBL	OBL	OBL	-5	OBL	Haloragaceae
PROSOPIS GLANDULOSA	UPL	UPL	UPL	5	UPL	Fabaceae
Prunella vulgaris var. lanceolata	FAC	FACU	FAC	3	FACU	Lamiaceae
PRUNELLA VULGARIS var. VULGARIS	FAC	FACU	FAC	3	FACU	Lamiaceae
Prunus americana	UPL	FACU	UPL	5	UPL	Rosaceae
Prunus angustifolia	upl	upl	upl	5	UPL	Rosaceae
PRUNUS ARMENIACA	upl	upl	upl	5	UPL	Rosaceae
PRUNUS CERASUS	upl	upl	upl	5	UPL	Rosaceae
Prunus hortulana	upl	upl	upl	5	UPL	Rosaceae
PRUNUS MAHALEB	upl	upl	upl	5	UPL	Rosaceae
Prunus mexicana	upl	upl	upl	5	UPL	Rosaceae
Prunus munsoniana	upl	upl	upl	5	UPL	Rosaceae
PRUNUS PERSICA	upl	upl	upl	5	UPL	Rosaceae
Prunus serotina	FACU	FACU	FACU	3	FACU	Rosaceae
PRUNUS SPINOSA	upl	upl	upl	5	UPL	Rosaceae
Prunus virginiana	FACU	FACU	FACU	3	FACU	Rosaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Pseudognaphalium helleri	upl	upl	upl	5	UPL	Asteraceae
Pseudognaphalium micradenium	upl	upl	upl	5	UPL	Asteraceae
Pseudognaphalium obtusifolium	upl	upl	upl	5	UPL	Asteraceae
Ptelea trifoliata	FACU	FAC	FACU	3	FACU	Rutaceae
Pteridium aquilinum	FACU	FACU	FACU	3	FACU	Dennstaedtiaceae
Ptilimnium capillaceum	OBL	OBL	OBL	-5	OBL	Apiaceae
Ptilimnium costatum	FACW	FACW	OBL	-5	OBL	Apiaceae
Ptilimnium nuttallii	FAC	FACW	FACW	-3	FACW	Apiaceae
PUCCINELLIA DISTANS	OBL	OBL	OBL	3	[FACU]	Poaceae
PUERARIA MONTANA var. LOBATA	FACU	UPL	UPL	5	UPL	Fabaceae
Pycnanthemum albescens	FAC	UPL	UPL	3	FACU	Lamiaceae
Pycnanthemum muticum	FAC	FACW	FAC	0	FAC	Lamiaceae
Pycnanthemum pilosum	UPL	FAC	UPL	3	FACU	Lamiaceae
Pycnanthemum tenuifolium	FACW	FACW	FAC	0	FAC	Lamiaceae
Pycnanthemum torrei	upl	upl	upl	5	UPL	Lamiaceae
Pycnanthemum virginianum	FAC	FAC	FACW	-3	FACW	Lamiaceae
PYRACANTHA COCCINEA	upl	upl	upl	5	UPL	Rosaceae
Pyrrhopappus carolinianus	upl	upl	upl	5	UPL	Asteraceae
PYRUS CALLERYANA	upl	upl	upl	5	UPL	Rosaceae
PYRUS COMMUNIS	upl	upl	upl	5	UPL	Rosaceae
QUERCUS ACUTISSIMA	upl	upl	upl	5	UPL	Fagaceae
Quercus alba	FACU	FACU	FACU	3	FACU	Fagaceae
Quercus bicolor	FACW	FACW	FACW	-3	FACW	Fagaceae
Quercus coccinea	upl	upl	upl	5	UPL	Fagaceae
Quercus ellipsoidalis	upl	upl	upl	5	UPL	Fagaceae
Quercus falcata	FACU	FACU	FACU	3	FACU	Fagaceae
Quercus imbricaria	FAC	FAC	FACU	3	FACU	Fagaceae
Quercus lyrata	OBL	OBL	OBL	-5	OBL	Fagaceae
Quercus macrocarpa	FACU	FAC	FAC	3	FACU	Fagaceae
Quercus marilandica	upl	upl	upl	5	UPL	Fagaceae
Quercus michauxii	FACW	FACW	FACW	-3	FACW	Fagaceae
Quercus muehlenbergii	UPL	UPL	FACU	5	UPL	Fagaceae
Quercus nigra	FAC	FAC	FACW	0	FAC	Fagaceae
Quercus pagoda	FACW	FACW	FACW	-3	FACW	Fagaceae
Quercus palustris	FACW	FACW	FACW	-3	FACW	Fagaceae
Quercus phellos	FACW	FAC	FACW	-3	FACW	Fagaceae
Quercus prinoides	UPL	UPL	FACU	5	UPL	Fagaceae
Quercus rubra	FACU	FACU	FACU	3	FACU	Fagaceae
Quercus shumardii var. acerifolia	[upl]	[upl]	[upl]	5	[UPL]	Fagaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Quercus shumardii var. shumardii	FAC	FAC	FACW	0	FAC	Fagaceae
Quercus similis	FACW	FACW	facw	-3	FACW	Fagaceae
Quercus stellata	UPL	UPL	FACU	5	UPL	Fagaceae
Quercus texana	FACW	OBL	OBL	-5	OBL	Fagaceae
Quercus velutina	UPL	UPL	UPL	5	UPL	Fagaceae
Ranunculus abortivus	FACW	FACW	FACW	-3	FACW	Ranunculaceae
RANUNCULUS ACRIS	FACW	FAC	FAC	0	FAC	Ranunculaceae
Ranunculus aquatilis var. diffusus	OBL	OBL	OBL	-5	OBL	Ranunculaceae
RANUNCULUS ARVENSIS	upl	upl	upl	5	UPL	Ranunculaceae
RANUNCULUS BULBOSUS	FAC	UPL	FAC	0	FAC	Ranunculaceae
Ranunculus cymbalaria	OBL	obl	OBL	-5	OBL	Ranunculaceae
Ranunculus fascicularis	FAC	FACU	FACU	3	FACU	Ranunculaceae
RANUNCULUS FICARIA	FAC	FAC	FAC	0	FAC	Ranunculaceae
Ranunculus flabellaris	OBL	OBL	OBL	-5	OBL	Ranunculaceae
Ranunculus harveyi	FACU	FACU	FACU	3	FACU	Ranunculaceae
Ranunculus hispidus var. caricetorum	FAC	FAC	FAC	0	FAC	Ranunculaceae
Ranunculus hispidus var. hispidus	FAC	FAC	FAC	3	[FACU]	Ranunculaceae
Ranunculus hispidus var. nitidus	FAC	FAC	FAC	0	FAC	Ranunculaceae
Ranunculus laxicaulis	OBL	OBL	OBL	-5	OBL	Ranunculaceae
Ranunculus micranthus	FACU	FACU	FACU	3	FACU	Ranunculaceae
RANUNCULUS PARVIFLORUS	FAC	FAC	FAC	0	FAC	Ranunculaceae
Ranunculus pusillus	FACW	OBL	OBL	-5	OBL	Ranunculaceae
Ranunculus recurvatus	FACW	FAC	FACW	-3	FACW	Ranunculaceae
RANUNCULUS REPENS	FAC	FAC	FAC	0	FAC	Ranunculaceae
RANUNCULUS SARDOUS	FAC	UPL	FAC	3	FACU	Ranunculaceae
Ranunculus sceleratus	OBL	OBL	OBL	-5	OBL	Ranunculaceae
RAPHANUS RAPHANISTRUM	upl	upl	upl	5	UPL	Brassicaceae
RAPHANUS SATIVUS	upl	upl	upl	5	UPL	Brassicaceae
RAPISTRUM RUGOSUM	upl	upl	upl	5	UPL	Brassicaceae
RATIBIDA COLUMNIFERA	upl	upl	upl	5	UPL	Asteraceae
Ratibida pinnata	upl	upl	upl	5	UPL	Asteraceae
RATIBIDA TAGETES	upl	upl	upl	5	UPL	Asteraceae
RESEDA LUTEA	UPL	UPL	UPL	5	UPL	Resedaceae
RESEDA LUTEOLA	upl	upl	upl	5	UPL	Resedaceae
Rhamnus caroliniana	FACU	FAC	FAC	3	FACU	Rhamnaceae
RHAMNUS CATHARTICA	FACU	FACU	FAC	0	FAC	Rhamnaceae
RHAMNUS DAVURICA	upl	upl	upl	5	UPL	Rhamnaceae
RHAMNUS JAPONICA	upl	upl	upl	5	UPL	Rhamnaceae
Rhamnus lanceolata	FAC	FAC	FACW	0	FAC	Rhamnaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Rhexia mariana var. interior	FACW	OBL	OBL	-5	OBL	Melastomaceae
Rhexia mariana var. mariana	FACW	OBL	OBL	-5	OBL	Melastomaceae
Rhexia virginica	FACW	OBL	OBL	-5	OBL	Melastomaceae
Rhododendron prinophyllum	FAC	FAC	FAC	5	[UPL]	Ericaceae
RHODOTYPOS SCANDENS	upl	upl	upl	5	UPL	Rosaceae
Rhus aromatica var. aromatica	UPL	UPL	UPL	5	UPL	Anacardiaceae
Rhus aromatica var. serotina	UPL	UPL	UPL	5	UPL	Anacardiaceae
Rhus copallinum var. latifolia	UPL	FACU	UPL	5	UPL	Anacardiaceae
Rhus glabra	upl	upl	upl	5	UPL	Anacardiaceae
RHUS TYPHINA	upl	upl	upl	5	UPL	Anacardiaceae
Rhynchosia difformis	upl	upl	upl	5	UPL	Fabaceae
Rhynchosia latifolia	upl	upl	upl	5	UPL	Fabaceae
Rhynchospora capillacea	OBL	OBL	OBL	-5	OBL	Cyperaceae
Rhynchospora capitellata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Rhynchospora corniculata	OBL	OBL	OBL	-5	OBL	Cyperaceae
Rhynchospora globularis var. recognita	facw	FACW	facw	-3	FACW	Cyperaceae
Rhynchospora harveyi	FACW	FAC	FAC	3	FAC	Cyperaceae
Rhynchospora macrostachya	OBL	OBL	OBL	-5	OBL	Cyperaceae
Rhynchospora scirpoides	OBL	OBL	OBL	-5	OBL	Cyperaceae
Ribes americanum	FACW	FACW	FACW	-3	FACW	Grossulariaceae
Ribes cynosbati	FACU	FACU	FAC	3	FACU	Grossulariaceae
Ribes missouriense	upl	upl	upl	5	UPL	Grossulariaceae
Ribes odoratum	FAC	FACW	FAC	5	[UPL]	Grossulariaceae
RICINUS COMMUNIS	FACU	UPL	FACU	3	FACU	Euphorbiaceae
ROBINIA HISPIDA	upl	upl	upl	5	UPL	Fabaceae
ROBINIA PSEUDOACACIA	UPL	FACU	FACU	3	FACU	Fabaceae
Robinia pseudoacacia	UPL	FACU	FACU	3	FACU	Fabaceae
Rorippa aquatica	OBL	OBL	OBL	-5	OBL	Brassicaceae
Rorippa curvipes	FACW	FACW	FACW	-3	FACW	Brassicaceae
Rorippa palustris var. fernaldiana	OBL	OBL	OBL	-5	OBL	Brassicaceae
Rorippa sessiliflora	OBL	OBL	OBL	-5	OBL	Brassicaceae
Rorippa sinuata	FACW	FACW	FACW	-3	FACW	Brassicaceae
RORIPPA SYLVESTRIS	OBL	FACW	OBL	-3	FACW	Brassicaceae
Rorippa tenerrima	fac	FAC	FAC	0	FAC	Brassicaceae
Rosa arkansana	FACU	FACU	FACU	3	FACU	Rosaceae
Rosa blanda	FACU	FACU	FACU	3	FACU	Rosaceae
ROSA CANINA	upl	upl	upl	5	UPL	Rosaceae
Rosa carolina subsp. carolina	FACU	FACU	FACU	3	FACU	Rosaceae
Rosa carolina subsp. subserrulata	FACU	FACU	FACU	3	FACU	Rosaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
ROSA GALLICA	upl	upl	upl	5	UPL	Rosaceae
ROSA LUCIEAE	upl	upl	upl	5	UPL	Rosaceae
ROSA MULTIFLORA	FACU	FACU	FACU	3	FACU	Rosaceae
Rosa palustris	OBL	OBL	OBL	-5	OBL	Rosaceae
ROSA RUBIGINOSA	UPL	UPL	UPL	5	UPL	Rosaceae
ROSA RUGOSA	FACU	FACU	FACU	3	FACU	Rosaceae
Rosa setigera	FACU	FACU	FACU	3	FACU	Rosaceae
ROSA SPINOSISSIMA	upl	upl	upl	5	UPL	Rosaceae
ROSA WOODSII	facu	facu	FACU	3	FACU	Rosaceae
Rotala ramosior	OBL	OBL	OBL	-5	OBL	Lythraceae
Rubus ablatus	FAC	FAC	UPL	3	FACU	Rosaceae
Rubus aboriginum	upl	upl	upl	5	UPL	Rosaceae
Rubus allegheniensis	UPL	FACU	FACU	3	FACU	Rosaceae
Rubus alumnus	FACU	FACU	FACU	3	FACU	Rosaceae
Rubus argutus	FAC	FACU	FAC	0	FAC	Rosaceae
RUBUS ARMENIACUS	upl	upl	upl	5	UPL	Rosaceae
Rubus celer	upl	upl	upl	5	UPL	Rosaceae
Rubus curtipes	upl	upl	upl	5	UPL	Rosaceae
Rubus deamii	upl	upl	upl	5	UPL	Rosaceae
Rubus enslenii	UPL	FACU	FACU	3	FACU	Rosaceae
Rubus flagellaris	UPL	FACU	FACU	3	FACU	Rosaceae
Rubus frondosus	upl	upl	upl	5	UPL	Rosaceae
RUBUS IDAEUS var. STRIGOSUS	FACU	FAC	FACU	3	FACU	Rosaceae
RUBUS LACINIATUS	UPL	UPL	UPL	5	UPL	Rosaceae
Rubus laudatus	FAC	FAC	UPL	3	FACU	Rosaceae
Rubus leviculus	upl	upl	upl	5	UPL	Rosaceae
Rubus meracus	upl	upl	upl	5	UPL	Rosaceae
Rubus missouricus	FACU	FACU	FACU	3	FACU	Rosaceae
Rubus mollior	upl	upl	upl	5	UPL	Rosaceae
Rubus occidentalis	upl	upl	upl	5	UPL	Rosaceae
RUBUS PARVIFOLIUS	FACU	FACU	facu	3	FACU	Rosaceae
RUBUS PHOENICOLASIUS	FACU	FACU	FACU	3	FACU	Rosaceae
Rubus plicatifolius	upl	upl	upl	5	UPL	Rosaceae
Rubus roribaccus	upl	upl	upl	5	UPL	Rosaceae
Rubus rosa	upl	upl	upl	5	UPL	Rosaceae
Rubus satis	upl	upl	upl	5	UPL	Rosaceae
RUBUS SERISSIMUS	upl	upl	upl	5	UPL	Rosaceae
Rubus steelei	upl	upl	upl	5	UPL	Rosaceae
Rubus trivialis	FACU	FACU	FACU	3	FACU	Rosaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Rudbeckia amplexicaulis	FAC	FAC	FACU	3	FACU	Asteraceae
Rudbeckia bicolor	upl	upl	upl	5	UPL	Asteraceae
Rudbeckia fulgida var. sullivantii	FAC	FAC	OBL	-3	FACW	Asteraceae
Rudbeckia fulgida var. umbrosa	FAC	FAC	OBL	-5	OBL	Asteraceae
RUDBECKIA GRANDIFLORA	upl	upl	upl	5	UPL	Asteraceae
Rudbeckia hirta	FACU	FACU	FACU	3	FACU	Asteraceae
Rudbeckia laciniata	FACW	FACW	FACW	-3	FACW	Asteraceae
RUDBECKIA MAXIMA	FAC	FAC	FAC	0	FAC	Asteraceae
Rudbeckia missouriensis	UPL	UPL	FACU	3	FACU	Asteraceae
Rudbeckia subtomentosa	FAC	FAC	FACU	3	FACU	Asteraceae
Rudbeckia triloba	FACU	FACU	FACU	3	FACU	Asteraceae
Ruellia humilis	FACU	FACU	FACU	3	FACU	Acanthaceae
Ruellia pedunculata	upl	upl	upl	5	UPL	Acanthaceae
Ruellia strepens	FAC	FAC	FAC	0	FAC	Acanthaceae
RUMEX ACETOSELLA	FACU	UPL	FACU	3	FACU	Polygonaceae
Rumex altissimus	FACW	FACW	FACW	-3	FACW	Polygonaceae
RUMEX CONGLOMERATUS	FACW	FAC	FACW	-3	FACW	Polygonaceae
RUMEX CRISPUS	FAC	FAC	FAC	0	FAC	Polygonaceae
RUMEX CRISTATUS	upl	upl	upl	5	UPL	Polygonaceae
RUMEX DENTATUS	facu	FACU	FACU	3	FACU	Polygonaceae
Rumex fueginus	OBL	OBL	FACW	-5	OBL	Polygonaceae
Rumex hastatulus	FACU	FACU	FACU	3	FACU	Polygonaceae
RUMEX OBTUSIFOLIUS	FACW	FACU	FACW	-3	FACW	Polygonaceae
RUMEX PATIENTIA	upl	upl	upl	5	UPL	Polygonaceae
RUMEX PULCHER	FACW	FACW	UPL	3	FACU	Polygonaceae
RUMEX STENOPHYLLUS	FACW	facw	FACW	-3	FACW	Polygonaceae
Rumex triangulivalvis	FACW	FACW	FACW	-3	FACW	Polygonaceae
Rumex verticillatus	FACW	OBL	OBL	-5	OBL	Polygonaceae
Ruppia maritima	OBL	OBL	obl	-5	OBL	Ruppiaceae
RUTA GRAVEOLENS	upl	upl	upl	5	UPL	Rutaceae
Sabatia angularis	FACW	FAC	FAC	0	FAC	Gentianaceae
Sabatia brachiata	FAC	FACU	fac	3	FACU	Gentianaceae
Sabatia campestris	FACU	FACU	FACU	3	FACU	Gentianaceae
Sacciolepis striata	OBL	OBL	OBL	-5	OBL	Poaceae
Sagina decumbens	FACU	FAC	FAC	0	FAC	Caryophyllaceae
SAGINA PROCUMBENS	FACW	FACW	FACW	-3	FACW	Caryophyllaceae
Sagittaria ambigua	OBL	OBL	OBL	-5	OBL	Alismataceae
Sagittaria brevirostra	OBL	OBL	OBL	-5	OBL	Alismataceae
Sagittaria calycina	OBL	OBL	OBL	-5	OBL	Alismataceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Sagittaria graminea	OBL	OBL	OBL	-5	OBL	Alismataceae
Sagittaria latifolia	OBL	OBL	OBL	-5	OBL	Alismataceae
Sagittaria platyphylla	OBL	OBL	OBL	-5	OBL	Alismataceae
Sagittaria rigida	OBL	OBL	OBL	-5	OBL	Alismataceae
SALICORNIA EUROPAEA	OBL	OBL	obl	-5	OBL	Chenopodiaceae
SALIX × FRAGILIS	FAC	FAC	FAC	0	FAC	Salicaceae
SALIX × SEPULCRALIS	FACW	FACW	FACW	-3	FACW	Salicaceae
SALIX ALBA	FACW	FACW	FACW	-3	FACW	Salicaceae
Salix amygdaloides	FACW	FACW	FACW	-3	FACW	Salicaceae
Salix caroliniana	OBL	OBL	OBL	-5	OBL	Salicaceae
Salix discolor	FACW	FACW	FACW	-3	FACW	Salicaceae
Salix eriocephala	FACW	FACW	FACW	-3	FACW	Salicaceae
Salix famelica	facw	FACW	FACW	-3	FACW	Salicaceae
Salix humilis	FACU	FACU	FACU	3	FACU	Salicaceae
Salix interior	OBL	FACW	FACW	-3	FACW	Salicaceae
Salix nigra	OBL	OBL	OBL	-5	OBL	Salicaceae
Salix petiolaris	FACW	FACW	OBL	-3	FACW	Salicaceae
SALIX PURPUREA	FACW	FACW	FACW	-3	FACW	Salicaceae
Salix sericea	OBL	OBL	OBL	-5	OBL	Salicaceae
SALSOLA COLLINA	upl	upl	upl	5	UPL	Chenopodiaceae
SALSOLA TRAGUS	FACU	FACU	FACU	3	FACU	Chenopodiaceae
Salvia azurea var. grandiflora	upl	upl	upl	5	UPL	Lamiaceae
SALVIA COCCINEA	upl	upl	upl	5	UPL	Lamiaceae
Salvia lyrata	FACU	FACU	FACW	3	FACU	Lamiaceae
Salvia reflexa	upl	upl	upl	5	UPL	Lamiaceae
Sambucus canadensis	FACW	FACU	FACW	0	FAC	Caprifoliaceae
Sambucus pubens	FACU	FACU	FACU	3	FACU	Caprifoliaceae
Samolus parviflorus	OBL	OBL	OBL	-5	OBL	Primulaceae
Sanguinaria canadensis	UPL	UPL	FACU	5	UPL	Papaveraceae
Sanicula canadensis	FACU	UPL	FACU	3	FACU	Apiaceae
Sanicula odorata	FACU	FACU	FAC	3	FACU	Apiaceae
Sanicula smallii	upl	upl	upl	5	UPL	Apiaceae
Sapindus saponaria var. drummondii	FACU	FACU	UPL	5	UPL	Sapindaceae
SAPONARIA OFFICINALIS	FACU	FACU	FACU	3	FACU	Caryophyllaceae
Sassafras albidum	FACU	FACU	FACU	3	FACU	Lauraceae
Saururus cernuus	OBL	OBL	OBL	-5	OBL	Saururaceae
SCABIOSA ATROPURPUREA	upl	upl	upl	5	UPL	Dipsacaceae
Schedonnardus paniculatus	upl	upl	upl	5	UPL	Poaceae
Schizachyrium scoparium	FACU	FACU	FACU	3	FACU	Poaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Schoenoplectus acutus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus americanus	OBL	OBL	OBL	-5	OBL	Cyperaceae
SCHOENOPLECTUS CALIFORNICUS	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus deltarum	FACW	FACW	OBL	-5	OBL	Cyperaceae
Schoenoplectus etuberculatus	OBL	OBL	obl	-5	OBL	Cyperaceae
Schoenoplectus hallii	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus heterochaetus	OBL	OBL	OBL	-5	OBL	Cyperaceae
SCHOENOPLECTUS MUCRONATUS	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus pungens	OBL	OBL	OBL	-5	OBL	Cyperaceae
SCHOENOPLECTUS PURSHIANUS	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus saximontanus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus subterminalis	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus tabernaemontani	OBL	OBL	OBL	-5	OBL	Cyperaceae
Schoenoplectus torreyi	OBL	OBL	OBL	-5	OBL	Cyperaceae
SCILLA SIBERICA	upl	upl	upl	5	UPL	Liliaceae
Scirpus atrovirens	OBL	OBL	OBL	-5	OBL	Cyperaceae
Scirpus cyperinus	OBL	FACW	OBL	-5	OBL	Cyperaceae
Scirpus divaricatus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Scirpus georgianus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Scirpus pallidus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Scirpus pedicellatus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Scirpus pendulus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Scirpus polyphyllus	OBL	OBL	OBL	-5	OBL	Cyperaceae
Scirpus rubricosus	OBL	FACW	OBL	-5	OBL	Cyperaceae
SCLERANTHUS ANNUUS	FACU	FACU	FACU	3	FACU	Caryophyllaceae
Scleria ciliata	FAC	FAC	FAC	0	FAC	Cyperaceae
Scleria oligantha	FAC	FACU	FACU	3	FACU	Cyperaceae
Scleria pauciflora	FAC	FACU	FACU	3	FACU	Cyperaceae
Scleria reticularis var. pubescens	FACW	OBL	OBL	-3	FACW	Cyperaceae
Scleria triglomerata	FACW	FAC	FAC	0	FAC	Cyperaceae
Scleria verticillata	OBL	OBL	OBL	-5	OBL	Cyperaceae
SCLEROCHLOA DURA	upl	upl	upl	5	UPL	Poaceae
Scrophularia lanceolata	FAC	FACU	FACU	3	FACU	Scrophulariaceae
Scrophularia marilandica	FACU	FACU	FACU	3	FACU	Scrophulariaceae
Scutellaria bushii	upl	upl	upl	5	UPL	Lamiaceae
Scutellaria elliptica	upl	upl	upl	5	UPL	Lamiaceae
Scutellaria galericulata	OBL	OBL	OBL	-5	OBL	Lamiaceae
Scutellaria incana	upl	upl	upl	5	UPL	Lamiaceae
Scutellaria lateriflora	OBL	FACW	OBL	-5	OBL	Lamiaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Scutellaria nervosa	FAC	FAC	FAC	0	FAC	Lamiaceae
Scutellaria ovata	UPL	FACU	FACU	3	FACU	Lamiaceae
Scutellaria parvula var. australis	FACU	UPL	FACU	3	FACU	Lamiaceae
Scutellaria parvula var. missouriensis	FACU	UPL	FACU	3	FACU	Lamiaceae
Scutellaria parvula var. parvula	FACU	UPL	FACU	3	FACU	Lamiaceae
SECALE CEREALE	upl	upl	upl	5	UPL	Poaceae
SECURIGERA VARIA	upl	upl	upl	5	UPL	Fabaceae
SEDUM ACRE	upl	upl	upl	5	UPL	Crassulaceae
SEDUM ERYTHROSTICTUM	upl	upl	upl	5	UPL	Crassulaceae
Sedum nuttallianum	upl	upl	upl	5	UPL	Crassulaceae
Sedum pulchellum	UPL	FACU	FACU	3	FACU	Crassulaceae
SEDUM PURPUREUM	upl	upl	upl	5	UPL	Crassulaceae
SEDUM REFLEXUM	upl	upl	upl	5	UPL	Crassulaceae
SEDUM SARMENTOSUM	upl	upl	upl	5	UPL	Crassulaceae
Sedum ternatum	FACU	FACU	FACU	5	[UPL]	Crassulaceae
Selaginella apoda	FACW	FACW	FACW	-3	FACW	Selaginellaceae
Selaginella eclipes	FACW	FACW	FACW	-3	FACW	Selaginellaceae
Selaginella rupestris	upl	upl	upl	5	UPL	Selaginellaceae
Selenia aurea	upl	upl	upl	5	UPL	Brassicaceae
SENECIO AMPULLACEUS	upl	upl	upl	5	UPL	Asteraceae
SENECIO VULGARIS	UPL	FACU	UPL	5	UPL	Asteraceae
Senna marilandica	FAC	FAC	FACW	0	FAC	Fabaceae
Senna obtusifolia	FACU	FACU	FACU	3	FACU	Fabaceae
SENNA OCCIDENTALIS	FAC	UPL	FACU	3	FACU	Fabaceae
SESAMUM INDICUM	upl	upl	upl	5	UPL	Pedaliaceae
Sesbania herbacea	FACW	FAC	FACW	-3	FACW	Fabaceae
SESBANIA VESICARIA	FAC	FAC	OBL	-3	FACW	Fabaceae
SETARIA FABERI	UPL	UPL	FACU	3	FACU	Poaceae
SETARIA GLAUCA	FAC	FAC	FAC	0	FAC	Poaceae
SETARIA ITALICA	FACU	FACU	FACU	3	FACU	Poaceae
Setaria parviflora	FACW	FAC	FAC	3	[FACU]	Poaceae
SETARIA VERTICILLATA	FAC	FAC	FAC	0	FAC	Poaceae
SETARIA VIRIDIS var. MAJOR	upl	upl	upl	5	UPL	Poaceae
SETARIA VIRIDIS var. VIRIDIS	upl	upl	upl	5	UPL	Poaceae
SHERARDIA ARVENSIS	upl	upl	upl	5	UPL	Rubiaceae
Sicyos angulatus	FACW	FACU	FACW	0	FAC	Cucurbitaceae
Sida elliottii	upl	upl	upl	5	UPL	Malvaceae
SIDA SPINOSA	FACU	UPL	FACU	3	FACU	Malvaceae
Sideroxylon lanuginosum subsp. oblongifolium	FACU	FACU	FACW	3	FACU	Sapotaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Sideroxylon lycioides	FAC	FACW	FACW	-3	FACW	Sapotaceae
Silene antirrhina	upl	upl	upl	5	UPL	Caryophyllaceae
Silene caroliniana var. wherryi	upl	upl	upl	5	UPL	Caryophyllaceae
SILENE CONOIDEA	upl	upl	upl	5	UPL	Caryophyllaceae
SILENE CSEREII	upl	upl	upl	5	UPL	Caryophyllaceae
SILENE DICHOTOMA	upl	upl	upl	5	UPL	Caryophyllaceae
SILENE DIOICA	upl	upl	upl	5	UPL	Caryophyllaceae
SILENE GALLICA	upl	upl	upl	5	UPL	Caryophyllaceae
SILENE LATIFOLIA	upl	upl	upl	5	UPL	Caryophyllaceae
Silene nivea	FAC	FAC	FACW	0	FAC	Caryophyllaceae
SILENE NOCTIFLORA	upl	upl	upl	5	UPL	Caryophyllaceae
Silene regia	upl	upl	upl	5	UPL	Caryophyllaceae
Silene stellata	upl	upl	upl	5	UPL	Caryophyllaceae
Silene virginica	upl	upl	upl	5	UPL	Caryophyllaceae
SILENE VULGARIS	upl	upl	upl	5	UPL	Caryophyllaceae
Silphium asteriscus	upl	upl	upl	5	UPL	Asteraceae
Silphium integrifolium var. integrifolium	FAC	FAC	FAC	5	[UPL]	Asteraceae
Silphium integrifolium var. laeve	FAC	FAC	FAC	5	[UPL]	Asteraceae
Silphium laciniatum	upl	upl	upl	5	UPL	Asteraceae
Silphium perfoliatum	FAC	FAC	FACW	-3	FACW	Asteraceae
SILPHIUM RADULA	upl	upl	upl	5	UPL	Asteraceae
Silphium terebinthinaceum	FACU	FACU	FAC	0	FAC	Asteraceae
SILYBUM MARIANUM	upl	upl	upl	5	UPL	Asteraceae
SINAPIS ALBA	upl	upl	upl	5	UPL	Brassicaceae
SINAPIS ARVENSIS	upl	upl	upl	5	UPL	Brassicaceae
SISYMBRIUM ALTISSIMUM	FACU	FACU	FACU	3	FACU	Brassicaceae
SISYMBRIUM LOESELII	upl	upl	upl	5	UPL	Brassicaceae
SISYMBRIUM OFFICINALE	upl	upl	upl	5	UPL	Brassicaceae
Sisyrinchium albidum	FAC	FAC	FACU	3	FACU	Iridaceae
Sisyrinchium angustifolium	FACW	FACW	FAC	0	FAC	Iridaceae
Sisyrinchium atlanticum	FACW	FACW	FACW	-3	FACW	Iridaceae
Sisyrinchium campestre	upl	upl	upl	5	UPL	Iridaceae
Sium suave	OBL	OBL	OBL	-5	OBL	Apiaceae
Smallanthus uvedalius	upl	upl	upl	5	UPL	Asteraceae
Smilax bona-nox	FAC	FACU	FACU	3	FACU	Smilacaceae
Smilax ecirrhata	upl	upl	upl	5	UPL	Smilacaceae
Smilax glauca	FAC	FACU	FACU	3	FACU	Smilacaceae
Smilax hispida	FAC	FAC	FAC	0	FAC	Smilacaceae
Smilax illinoensis	upl	upl	upl	5	UPL	Smilacaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Smilax lasioneuron	upl	upl	upl	5	UPL	Smilacaceae
Smilax pulverulenta	FAC	FACU	FACU	3	FACU	Smilacaceae
Smilax rotundifolia	FAC	FAC	FAC	0	FAC	Smilacaceae
Solanum americanum	FACU	FACU	FACU	3	FACU	Solanaceae
Solanum carolinense	FACU	FACU	FACU	3	FACU	Solanaceae
SOLANUM DIMIDIATUM	upl	upl	upl	5	UPL	Solanaceae
SOLANUM DULCAMARA	FAC	FAC	FAC	0	FAC	Solanaceae
Solanum elaeagnifolium	upl	upl	upl	5	UPL	Solanaceae
SOLANUM LYCOPERSICUM	upl	upl	upl	5	UPL	Solanaceae
SOLANUM NIGRUM	FACU	FACU	facu	3	FACU	Solanaceae
SOLANUM PSEUDOCAPSICUM	upl	upl	upl	5	UPL	Solanaceae
Solanum ptycanthum	FACU	FACU	FACU	3	FACU	Solanaceae
SOLANUM ROSTRATUM	upl	upl	upl	5	UPL	Solanaceae
SOLANUM SARACHOIDES	upl	upl	upl	5	UPL	Solanaceae
SOLANUM TRIFLORUM	upl	upl	upl	5	UPL	Solanaceae
SOLANUM TUBEROSUM	upl	upl	upl	5	UPL	Solanaceae
Solidago altissima var. altissima	FACU	FACU	FACU	3	FACU	Asteraceae
Solidago altissima var. gilvicanescens	FACU	FACU	FACU	3	FACU	Asteraceae
Solidago arguta	UPL	UPL	UPL	5	UPL	Asteraceae
Solidago buckleyi	upl	upl	upl	5	UPL	Asteraceae
Solidago caesia	FACU	FACU	FACU	3	FACU	Asteraceae
Solidago canadensis var. hargeri	FACU	FACU	FACU	3	FACU	Asteraceae
Solidago drummondii	upl	upl	upl	5	UPL	Asteraceae
Solidago flexicaulis	FACU	FACU	FACU	3	FACU	Asteraceae
Solidago gattingeri	upl	upl	upl	5	UPL	Asteraceae
Solidago gigantea	FACW	FACW	FACW	-3	FACW	Asteraceae
Solidago hispida	upl	upl	upl	5	UPL	Asteraceae
Solidago juncea	upl	upl	upl	5	UPL	Asteraceae
Solidago missouriensis subsp. fasciculata	upl	upl	upl	5	UPL	Asteraceae
Solidago nemoralis var. longipetiolata	upl	upl	upl	5	UPL	Asteraceae
Solidago nemoralis var. nemoralis	upl	upl	upl	5	UPL	Asteraceae
Solidago odora	upl	upl	upl	5	UPL	Asteraceae
Solidago patula	OBL	OBL	OBL	-5	OBL	Asteraceae
Solidago petiolaris	upl	upl	upl	5	UPL	Asteraceae
Solidago radula	upl	upl	upl	5	UPL	Asteraceae
Solidago rugosa	FAC	FAC	FAC	0	FAC	Asteraceae
Solidago speciosa var. rigidiuscula	upl	upl	upl	5	UPL	Asteraceae
Solidago speciosa var. speciosa	upl	upl	upl	5	UPL	Asteraceae
Solidago ulmifolia	upl	upl	upl	5	UPL	Asteraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO	FAMILY
SONCHUS ARVENSIS subsp. ARVENSIS	UPL	FACU	FACU	3 FACU	Asteraceae
SONCHUS ARVENSIS subsp. ULIGINOSUS	UPL	FACU	FACU	3 FACU	Asteraceae
SONCHUS ASPER	FACU	FAC	FACU	3 FACU	Asteraceae
SONCHUS OLERACEUS	FACU	UPL	FACU	3 FACU	Asteraceae
Sorghastrum nutans	FACU	FACU	FACU	3 FACU	Poaceae
SORGHUM BICOLOR	FACU	UPL	UPL	5 UPL	Poaceae
SORGHUM HALEPENSE	FACU	FACU	FACU	3 FACU	Poaceae
Sparganium americanum	OBL	OBL	OBL	-5 OBL	Sparganiaceae
Sparganium androcladum	OBL	OBL	OBL	-5 OBL	Sparganiaceae
Sparganium eurycarpum	OBL	OBL	OBL	-5 OBL	Sparganiaceae
Spartina pectinata	OBL	OBL	FACW	-3 FACW	Poaceae
SPERGULA ARVENSIS	upl	upl	upl	5 UPL	Caryophyllaceae
SPERGULARIA SALINA	OBL	OBL	OBL	-5 OBL	Caryophyllaceae
Spermacoce glabra	FACW	FACW	FACW	-3 FACW	Rubiaceae
Spermolepis divaricata	FAC	FACU	FACU	3 FACU	Apiaceae
Spermolepis echinata	FACU	FACU	FACU	3 FACU	Apiaceae
Spermolepis inermis	upl	upl	upl	5 UPL	Apiaceae
SPHAERALCEA FENDLERI	upl	upl	upl	5 UPL	Malvaceae
SPHENOCLEA ZEYLANDICA	FACW	OBL	obl	-5 OBL	Sphenocleaceae
Sphenopholis nitida	UPL	FAC	FAC	5 UPL	Poaceae
Sphenopholis obtusata var. major	FAC	FAC	FAC	0 FAC	Poaceae
Sphenopholis obtusata var. obtusata	FAC	FAC	FAC	0 FAC	Poaceae
Sphenopholis pensylvanica	OBL	OBL	OBL	-5 OBL	Poaceae
Spigelia marilandica	upl	upl	upl	5 UPL	Loganiaceae
SPIRAEA × VANHOUTTEI	upl	upl	upl	5 UPL	Rosaceae
Spiraea alba	FACW	FACW	FACW	-3 FACW	Rosaceae
SPIRAEA DOUGLASII	UPL	UPL	UPL	5 UPL	Rosaceae
SPIRAEA JAPONICA	FACU	FACU	UPL	5 UPL	Rosaceae
SPIRAEA PRUNIFOLIA	upl	upl	upl	5 UPL	Rosaceae
Spiraea tomentosa	FACW	FACW	FACW	-3 FACW	Rosaceae
Spiranthes cernua	FACW	FACW	FACW	-3 FACW	Orchidaceae
Spiranthes lacera	FAC	FACU	FAC	0 FAC	Orchidaceae
Spiranthes lucida	FACW	FACW	FACW	-3 FACW	Orchidaceae
Spiranthes magnicamporum	FACU	FACU	FAC	3 FACU	Orchidaceae
Spiranthes ovalis var. erostellata	FAC	FAC	FAC	0 FAC	Orchidaceae
Spiranthes tuberosa	FACU	FACU	UPL	5 UPL	Orchidaceae
Spiranthes vernalis	FACW	FAC	FAC	0 FAC	Orchidaceae
Spirodela polyrhiza	OBL	OBL	OBL	-5 OBL	Lemnaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
SPIRODELA PUNCTATA	OBL	OBL	OBL	-5	OBL	Lemnaceae
SPOROBOLUS AIROIDES	FAC	FAC	FAC	0	FAC	Poaceae
Sporobolus clandestinus	upl	upl	upl	5	UPL	Poaceae
Sporobolus compositus var. compositrus	UPL	UPL	UPL	5	UPL	Poaceae
Sporobolus compositus var. drummondii	UPL	UPL	UPL	5	UPL	Poaceae
Sporobolus compositus var. macer	UPL	UPL	UPL	5	UPL	Poaceae
Sporobolus cryptandrus	UPL	UPL	FACU	5	UPL	Poaceae
Sporobolus heterolepis	UPL	UPL	FACU	3	FACU	Poaceae
SPOROBOLUS INDICUS	FACU	FACU	FACU	3	FACU	Poaceae
Sporobolus neglectus	UPL	FACU	UPL	5	UPL	Poaceae
Sporobolus ozarkanus	UPL	UPL	UPL	5	UPL	Poaceae
SPOROBOLUS PYRAMIDATUS	FAC	UPL	UPL	5	UPL	Poaceae
Sporobolus vaginiflorus	UPL	UPL	UPL	5	UPL	Poaceae
Stachys aspera	FAC	FACW	FACW	-3	FACW	Lamiaceae
Stachys hispida	FACW	FACW	OBL	-3	FACW	Lamiaceae
Stachys pilosa	FACW	FACW	FACW	-3	FACW	Lamiaceae
Stachys tenuifolia	FACW	FACW	OBL	-3	FACW	Lamiaceae
Staphylea trifolia	FAC	FAC	FAC	0	FAC	Staphyleaceae
Steinchisma hians	OBL	FACW	FACW	-3	FACW	Poaceae
STELLARIA GRAMINEA	FAC	FACU	UPL	3	FACU	Caryophyllaceae
Stellaria longifolia	FACW	FACW	FACW	-3	FACW	Caryophyllaceae
STELLARIA MEADIA	FACU	UPL	FACU	3	FACU	Caryophyllaceae
STELLARIA NEGLECTA	FACU	UPL	FACU	3	FACU	Caryophyllaceae
STELLARIA PALLIDA	FACU	UPL	FACU	3	FACU	Caryophyllaceae
Stenanthium gramineum	FAC	FACW	FAC	0	FAC	Liliaceae
Stenosiphon linifolius	upl	upl	upl	5	UPL	Onagraceae
STENOTAPHRUM SECUNDATUM	FAC	FAC	fac	0	FAC	Poaceae
Stipa spartea	upl	upl	upl	5	UPL	Poaceae
Strophostyles helvola var. helvola	FAC	FACU	FAC	0	FAC	Fabaceae
Strophostyles helvola var. missouriensis	FAC	FACU	FAC	0	FAC	Fabaceae
Strophostyles leiosperma	upl	upl	upl	5	UPL	Fabaceae
Strophostyles umbellata	FAC	FACU	FACU	3	FACU	Fabaceae
Stylisma pickeringii var. pattersonii	FAC	FAC	UPL	3	FACU	Convolvulaceae
Stylophorum diphyllum	upl	upl	upl	5	UPL	Papaveraceae
Stylosanthes biflora	upl	upl	upl	5	UPL	Fabaceae
Styrax americanus	FACW	OBL	OBL	-5	OBL	Styracaceae
Styrax grandifolius	FACU	FACU	UPL	5	UPL	Styracaceae
SUAEDA CALCEOLIFORMIS	FACW	FACW	FACW	-3	FACW	Chenopodiaceae
Sullivantia sullivantii	upl	upl	upl	5	UPL	Saxifragaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO	FAMILY
SYMPHORICARPOS ALBUS	FACU	FACU	FACU	3 FACU	Caprifoliaceae
Symphoricarpos occidentalis	FAC	UPL	UPL	5 UPL	Caprifoliaceae
Symphoricarpos orbiculatus	FACU	FACU	FACU	3 FACU	Caprifoliaceae
Symphyotrichum × amethystinum	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum anomalum	upl	upl	upl	5 UPL	Asteraceae
SYMPHYOTRICHUM CILIATUM	fac	FAC	FAC	0 FAC	Asteraceae
Symphyotrichum cordifolium	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum drummondii	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum dumosum var. strictior	FAC	FAC	FAC	0 FAC	Asteraceae
Symphyotrichum ericoides	UPL	FACU	FACU	5 UPL	Asteraceae
SYMPHYOTRICHUM FALCATUM subsp. COMMUTATUM	FAC	FAC	FAC	0 FAC	Asteraceae
Symphyotrichum laeve	UPL	FACU	FACU	5 UPL	Asteraceae
Symphyotrichum lanceolatum var. interior	FACW	FACW	FAC	-3 FACW	Asteraceae
Symphyotrichum lanceolatum var. lanceolatum	FACW	FACW	FAC	-3 FACW	Asteraceae
Symphyotrichum lateriflorum	FAC	FACW	FACW	-3 FACW	Asteraceae
Symphyotrichum novae-angliae	FACW	FACW	FACW	-3 FACW	Asteraceae
Symphyotrichum oblongifolium	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum ontarionis	FAC	FAC	FAC	0 FAC	Asteraceae
Symphyotrichum oolentangiense	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum parviceps	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum patens	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum pilosum var. pilosum	FACW	FAC	FACU	0 FAC	Asteraceae
Symphyotrichum pilosum var. pringlei	FACW	FAC	FACU	0 FAC	Asteraceae
Symphyotrichum praealtum	FACW	FACW	FACW	-3 FACW	Asteraceae
Symphyotrichum puniceum	OBL	OBL	OBL	-5 OBL	Asteraceae
Symphyotrichum racemosum var. subdumosum	FACW	FACW	FACW	-3 FACW	Asteraceae
Symphyotrichum sericeum	upl	upl	upl	5 UPL	Asteraceae
SYMPHYOTRICHUM SUBULATUM var. LIGULATUM	OBL	OBL	OBL	-5 OBL	Asteraceae
Symphyotrichum turbinellum	upl	upl	upl	5 UPL	Asteraceae
Symphyotrichum urophyllum	upl	upl	upl	5 UPL	Asteraceae
SYMPHYTUM OFFICINALE	upl	upl	upl	5 UPL	Boraginaceae
SYRINGA VULGARIS	upl	upl	upl	5 UPL	Oleaceae
Taenidia integerrima	upl	upl	upl	5 UPL	Apiaceae
TAGETES ERECTA	UPL	UPL	UPL	5 UPL	Asteraceae
TAGETES PATULA	upl	upl	upl	5 UPL	Asteraceae
TALINUM PANICULATUM	upl	upl	upl	5 UPL	Portulacaceae
TAMARIX RAMOSISSIMA	upl	upl	upl	5 UPL	Tamaricaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
TANACETUM BALSAMITA	upl	upl	upl	5	UPL	Asteraceae
TANACETUM PARTHENIUM	upl	upl	upl	5	UPL	Asteraceae
TANACETUM VULGARE	UPL	UPL	UPL	5	UPL	Asteraceae
TARAXACUM ERYTHROSPERMUM	upl	upl	upl	5	UPL	Asteraceae
TARAXACUM OFFICINALE	FACU	FACU	FACU	3	FACU	Asteraceae
Taxodium distichum	OBL	OBL	OBL	-5	OBL	Cupressaceae
Tephrosia virginiana	upl	upl	upl	5	UPL	Fabaceae
TETRADIUM DANIELII	upl	upl	upl	5	UPL	Rutaceae
Teucrium canadense var. canadense	FACW	FACW	FACW	-3	FACW	Lamiaceae
Teucrium canadense var. occidentale	FACW	FACW	FACW	-3	FACW	Lamiaceae
Thalia dealbata	OBL	OBL	OBL	-5	OBL	Marantaceae
Thalictrum dasycarpum	FAC	FACW	FACW	-3	FACW	Ranunculaceae
Thalictrum dioicum	FAC	FAC	FACU	3	FACU	Ranunculaceae
Thalictrum revolutum	FAC	FAC	FAC	0	FAC	Ranunculaceae
Thalictrum thalictroides	FACU	FACU	FACU	3	FACU	Ranunculaceae
Thaspium barbinode	UPL	FACU	FACU	3	FACU	Apiaceae
Thaspium trifoliatum var. flavum	upl	upl	upl	5	UPL	Apiaceae
Thaspium trifoliatum var. trifoliatum	upl	upl	upl	5	UPL	Apiaceae
Thelesperma filifolium	upl	upl	upl	5	UPL	Asteraceae
THELESPERMA MEGAPOTAMICUM	upl	upl	upl	5	UPL	Asteraceae
Thelypteris palustris var. pubescens	OBL	FACW	OBL	-5	OBL	Thelypteridaceae
THLASPI ALLIACEUM	upl	upl	upl	5	UPL	Brassicaceae
THLASPI ARVENSE	upl	upl	upl	5	UPL	Brassicaceae
TIDESTROMIA LANUGINOSA	upl	upl	upl	5	UPL	Amaranthaceae
Tilia americana var. americana	FACU	FACU	FACU	3	FACU	Malvaceae
Tilia americana var. heterophylla	FACU	FACU	FACU	3	FACU	Malvaceae
Tipularia discolor	FACU	FACU	FACU	3	FACU	Orchidaceae
TIQUILIA NUTTALLII	facu	FACU	facu	3	FACU	Boraginaceae
TORILIS ARVENSIS	upl	upl	upl	5	UPL	Apiaceae
TORILIS JAPONICA	upl	upl	upl	5	UPL	Apiaceae
TORILIS NODOSA	upl	upl	upl	5	UPL	Apiaceae
Torreyochloa pallida	OBL	OBL	OBL	-5	OBL	Poaceae
Toxicodendron pubescens	FACU	FACU	FACU	3	FACU	Anacardiaceae
Toxicodendron radicans	FAC	FAC	FAC	0	FAC	Anacardiaceae
Trachelospermum difforme	FACW	FACW	FACW	-3	FACW	Apocynaceae
Tradescantia bracteata	FAC	UPL	FACU	3	FACU	Commelinaceae
Tradescantia ernestiana	upl	upl	upl	5	UPL	Commelinaceae
Tradescantia longipes	upl	upl	upl	5	UPL	Commelinaceae
Tradescantia ohiensis	FAC	FAC	FACU	3	FACU	Commelinaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Tradescantia ozarkana	upl	upl	upl	5	UPL	Commelinaceae
Tradescantia subaspera	upl	upl	upl	5	UPL	Commelinaceae
Tradescantia tharpii	upl	upl	upl	5	UPL	Commelinaceae
Tradescantia virginiana	FAC	FACU	UPL	3	FACU	Commelinaceae
Tragia betonicifolia	upl	upl	upl	5	UPL	Euphorbiaceae
Tragia cordata	upl	upl	upl	5	UPL	Euphorbiaceae
Tragia ramosa	upl	upl	upl	5	UPL	Euphorbiaceae
TRAGOPOGON DUBIUS	upl	upl	upl	5	UPL	Asteraceae
TRAGOPOGON PORRIFOLIUS	upl	upl	upl	5	UPL	Asteraceae
TRAGOPOGON PRATENSIS	upl	upl	upl	5	UPL	Asteraceae
Trautvettaria caroliniensis	FACW	FACW	FAC	-3	FACW	Ranunculaceae
Trepocarpus aethusae	FACW	FACW	OBL	-5	OBL	Apiaceae
Triadenum tubulosum	OBL	OBL	OBL	-5	OBL	Clusiaceae
Triadenum walteri	OBL	OBL	OBL	-5	OBL	Clusiaceae
TRIANTHEMA PORTULACASTRUM	FACW	UPL	FACW	3	FACU	Aizoaceae
TRIBULUS TERRESTRIS	upl	upl	upl	5	UPL	Zygophyllaceae
Trichophorum planifolium	upl	upl	upl	5	UPL	Cyperaceae
Trichostema brachiatum	upl	upl	upl	5	UPL	Lamiaceae
Trichostema dichotomum	UPL	UPL	UPL	5	UPL	Lamiaceae
Trichostema setaceum	upl	upl	upl	5	UPL	Lamiaceae
Tridens flavus var. chapmanii	FACU	FACU	UPL	3	FACU	Poaceae
Tridens flavus var. flavus	FACU	FACU	UPL	3	FACU	Poaceae
Tridens muticus var. elongatus	FACW	FAC	FAC	5	[FACU]	Poaceae
Tridens strictus	FACW	FACW	FACU	3	FACU	Poaceae
TRIFOLIUM ARVENSE	upl	upl	upl	5	UPL	Fabaceae
TRIFOLIUM AUREUM	upl	upl	upl	5	UPL	Fabaceae
TRIFOLIUM CAMPESTRE	upl	upl	upl	5	UPL	Fabaceae
Trifolium carolinianum	upl	upl	upl	5	UPL	Fabaceae
TRIFOLIUM DUBIUM	FACU	UPL	FACU	3	FACU	Fabaceae
TRIFOLIUM HYBRIDUM	FACU	FACU	FACU	3	FACU	Fabaceae
TRIFOLIUM INCARNATUM	upl	upl	upl	5	UPL	Fabaceae
TRIFOLIUM PRATENSE	FACU	FACU	FACU	3	FACU	Fabaceae
Trifolium reflexum	upl	upl	upl	5	UPL	Fabaceae
TRIFOLIUM REPENS	FACU	FACU	FACU	3	FACU	Fabaceae
TRIFOLIUM RESUPINATUM	FACU	UPL	UPL	5	UPL	Fabaceae
Trifolium stoloniferum	upl	upl	upl	5	UPL	Fabaceae
TRIFOLIUM STRIATUM	upl	upl	upl	5	UPL	Fabaceae
TRIFOLIUM VESCICULOSUM	upl	upl	upl	5	UPL	Fabaceae
Trillium flexipes	FAC	FAC	FACU	0	FAC	Liliaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Trillium nivale	upl	upl	upl	5	UPL	Liliaceae
Trillium pusillum var. ozarkanum	FACW	FACW	upl	5	UPL	Liliaceae
Trillium recurvatum	FACU	UPL	FACU	3	FACU	Liliaceae
Trillium sessile	UPL	UPL	FACU	5	UPL	Liliaceae
Trillium viride	upl	upl	upl	5	UPL	Liliaceae
Trillium viridescens	upl	upl	upl	5	UPL	Liliaceae
Triodanis biflora	upl	upl	upl	5	UPL	Campanulaceae
Triodanis holzingeri	upl	upl	upl	5	UPL	Campanulaceae
Triodanis lamprosperma	upl	upl	upl	5	UPL	Campanulaceae
Triodanis leptocarpa	upl	upl	upl	5	UPL	Campanulaceae
Triodanis perfoliata	FACU	FAC	FAC	3	FACU	Campanulaceae
Triosteum angustifolium	UPL	FAC	FAC	3	FACU	Caprifoliaceae
Triosteum aurantiacum	upl	upl	upl	5	UPL	Caprifoliaceae
Triosteum perfoliatum	upl	upl	upl	5	UPL	Caprifoliaceae
Triphora trianthophora	FACW	UPL	FACU	0	FAC	Orchidaceae
Triplasis purpurea	upl	upl	upl	5	UPL	Poaceae
TRIPLEUROSPERMUM INODORUM	upl	upl	upl	5	UPL	Asteraceae
Tripsacum dactyloides	FAC	FACW	FAC	0	FAC	Poaceae
TRISETUM FLAVESCENS	upl	upl	upl	5	UPL	Poaceae
TRITICUM AESTIVUM	upl	upl	upl	5	UPL	Poaceae
TSUGA CANADENIS	FACU	FACU	FACU	3	FACU	Pinaceae
Turritis glabra	upl	upl	upl	5	UPL	Brassicaceae
Typha × glauca	OBL	OBL	OBL	-5	OBL	Typhaceae
Typha angustifolia	OBL	OBL	OBL	-5	OBL	Typhaceae
Typha domingensis	OBL	OBL	OBL	-5	OBL	Typhaceae
Typha latifolia	OBL	OBL	OBL	-5	OBL	Typhaceae
ULMUS × INTERMEDIA	upl	upl	upl	5	UPL	Ulmaceae
Ulmus alata	FACU	FACU	FACU	3	FACU	Ulmaceae
Ulmus americana	FAC	FACW	FACW	0	FAC	Ulmaceae
Ulmus crassifolia	FAC	FAC	FAC	0	FAC	Ulmaceae
ULMUS MINOR	upl	upl	upl	5	UPL	Ulmaceae
ULMUS PUMILA	FACU	FACU	UPL	3	FACU	Ulmaceae
Ulmus rubra	FAC	FAC	FAC	0	FAC	Ulmaceae
Ulmus thomasi	FAC	FACU	FAC	0	FAC	Ulmaceae
UROCHLOA PLATYPHYLLA	FAC	FAC	FAC	0	FAC	Poaceae
UROCHLOA RAMOSA	FACU	FACU	facu	3	FACU	Poaceae
UROCHLOA TEXANA	upl	upl	upl	5	UPL	Poaceae
Urtica chamaedryoides	FAC	FACU	FACU	3	FACU	Urticaceae
URTICA DIOICA subsp. DIOICA	FAC	FACU	FACW	0	FAC	Urticaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Urtica dioica subsp. gracilis	FAC	FACU	FACW	0	FAC	Urticaceae
URTICA URENS	upl	upl	upl	5	UPL	Urticaceae
Utricularia gibba	OBL	OBL	OBL	-5	OBL	Lentibulariaceae
Utricularia minor	OBL	OBL	OBL	-5	OBL	Lentibulariaceae
Utricularia subulata	OBL	OBL	OBL	-5	OBL	Lentibulariaceae
Utricularia vulgaris subsp. macrorhiza	OBL	OBL	OBL	-5	OBL	Lentibulariaceae
Uvularia grandiflora	upl	upl	upl	5	UPL	Liliaceae
Uvularia sessilifolia	FAC	FAC	FACU	3	FACU	Liliaceae
VACCARIA HISPANICA	upl	upl	upl	5	UPL	Caryophyllaceae
Vaccinium arboreum	FACU	FACU	FACU	3	FACU	Ericaceae
VACCINIUM CORYMBOSUM	FACW	FACW	FACW	-3	FACW	Ericaceae
Vaccinium pallidum	upl	upl	upl	5	UPL	Ericaceae
Vaccinium stamineum	FACU	FACU	FACU	3	FACU	Ericaceae
VALERIANELLA LOCUSTA	upl	upl	upl	5	UPL	Valerianaceae
Valerianella ozarkana	upl	upl	upl	5	UPL	Valerianaceae
Valerianella radiata	FAC	FAC	FAC	0	FAC	Valerianaceae
Vallisneria americana	OBL	OBL	OBL	-5	OBL	Hydrocharitaceae
Veratrum woodii	upl	upl	upl	5	UPL	Liliaceae
VERBASCUM BLATTARIA	FACU	UPL	FACU	3	FACU	Scrophulariaceae
VERBASCUM LYCHNITIS	upl	upl	upl	5	UPL	Scrophulariaceae
VERBASCUM PHLOMOIDES	upl	upl	upl	5	UPL	Scrophulariaceae
VERBASCUM THAPSUS	FACU	FACU	UPL	5	UPL	Scrophulariaceae
VERBENA BONARIENSIS	FAC	FAC	FACU	3	FACU	Verbenaceae
Verbena bracteata	FACU	UPL	FACU	3	FACU	Verbenaceae
VERBENA BRASILIENSIS	upl	upl	upl	5	UPL	Verbenaceae
Verbena hastata	FAC	FACW	FACW	-3	FACW	Verbenaceae
Verbena simplex	upl	upl	upl	5	UPL	Verbenaceae
Verbena stricta	upl	upl	upl	5	UPL	Verbenaceae
Verbena urticifolia	FAC	FAC	FAC	0	FAC	Verbenaceae
Verbesina alternifolia	FAC	FAC	FACW	-3	FACW	Asteraceae
VERBESINA ENCELIOIDES	FAC	FACU	FAC	3	FACU	Asteraceae
Verbesina helianthoides	upl	upl	upl	5	UPL	Asteraceae
Verbesina virginica	FACU	UPL	FACU	3	FACU	Asteraceae
Vernonia arkansana	FAC	FAC	FAC	0	FAC	Asteraceae
Vernonia baldwinii	UPL	UPL	UPL	5	UPL	Asteraceae
Vernonia fasciculata	FACW	FAC	FACW	-3	FACW	Asteraceae
Vernonia gigantea	FAC	FAC	FAC	0	FAC	Asteraceae
Vernonia missurica	FAC	FACU	FAC	0	FAC	Asteraceae
Veronica americana	OBL	OBL	OBL	-5	OBL	Plantaginaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
VERONICA ANAGALLIS-AQUATICA	OBL	OBL	OBL	-5	OBL	Plantaginaceae
VERONICA ARVENSIS	UPL	UPL	FACU	3	FACU	Plantaginaceae
VERONICA BECCABUNGA	OBL	OBL	OBL	-5	OBL	Plantaginaceae
Veronica catenata	OBL	OBL	OBL	-5	OBL	Plantaginaceae
VERONICA CHAMAEDRYS	UPL	UPL	UPL	5	UPL	Plantaginaceae
VERONICA HEDERIFOLIA	upl	upl	upl	5	UPL	Plantaginaceae
VERONICA LONGIFOLIA	upl	upl	upl	5	UPL	Plantaginaceae
Veronica peregrina	FAC	FAC	FACW	0	FAC	Plantaginaceae
VERONICA PERSICA	upl	upl	upl	5	UPL	Plantaginaceae
VERONICA POLITA	upl	upl	upl	5	UPL	Plantaginaceae
VERONICA SCHEEREI	upl	upl	upl	5	UPL	Plantaginaceae
VERONICA SERPYLLIFOLIA	FAC	FAC	FACW	0	FAC	Plantaginaceae
VERONICA TEUCRIUM	upl	upl	upl	5	UPL	Plantaginaceae
VERONICA TRIPHYLLOS	upl	upl	upl	5	UPL	Plantaginaceae
Veronicastrum virginicum	FACW	FACU	FAC	0	FAC	Plantaginaceae
Viburnum bracteatum	upl	upl	upl	5	UPL	Caprifoliaceae
Viburnum dentatum	FAC	FAC	FAC	0	FAC	Caprifoliaceae
VIBURNUM LANTANA	upl	upl	upl	5	UPL	Caprifoliaceae
Viburnum lentago	FAC	FAC	FAC	0	FAC	Caprifoliaceae
Viburnum molle	upl	upl	upl	5	UPL	Caprifoliaceae
VIBURNUM OPULUS var. OPULUS	FACW	FACW	FAC	0	FAC	Caprifoliaceae
Viburnum prunifolium	FACU	FACU	FACU	3	FACU	Caprifoliaceae
Viburnum rafinesquianum	upl	upl	upl	5	UPL	Caprifoliaceae
Viburnum recognitum	FAC	FAC	FAC	0	FAC	Caprifoliaceae
Viburnum rufidulum	UPL	UPL	FACU	5	UPL	Caprifoliaceae
Vicia americana	FACU	FACU	FACU	3	FACU	Fabaceae
Vicia caroliniana	FACU	FACU	UPL	5	UPL	Fabaceae
VICIA CRACCA	upl	upl	upl	5	UPL	Fabaceae
VICIA GRANDIFLORA	upl	upl	upl	5	UPL	Fabaceae
VICIA HIRSUTA	upl	upl	upl	5	UPL	Fabaceae
Vicia ludoviciana	FACU	FACU	UPL	5	UPL	Fabaceae
Vicia minutiflora	upl	upl	upl	5	UPL	Fabaceae
VICIA SATIVA subsp. NIGRA	FACU	FACU	FACU	3	FACU	Fabaceae
VICIA VILLOSA subsp. VARIA	upl	upl	upl	5	UPL	Fabaceae
VICIA VILLOSA subsp. VILLOSA	upl	upl	upl	5	UPL	Fabaceae
VIGNA UNGUICULATA	upl	upl	upl	5	UPL	Fabaceae
VINCA MAJOR	upl	upl	upl	5	UPL	Apocynaceae
VINCA MINOR	upl	upl	upl	5	UPL	Apocynaceae
Viola affinis	FACW	FACW	FACW	-3	FACW	Violaceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
VIOLA ARVENSIS	upl	upl	upl	5	UPL	Violaceae
Viola bicolor	FAC	FACU	FACU	3	FACU	Violaceae
Viola cucullata	OBL	FACW	OBL	-5	OBL	Violaceae
Viola lanceolata	OBL	OBL	OBL	-5	OBL	Violaceae
Viola missouriensis	FAC	FACU	FACW	0	FAC	Violaceae
Viola nephrophylla	FACW	FACW	FACW	-3	FACW	Violaceae
Viola pallens	FACW	FACW	OBL	-5	OBL	Violaceae
Viola palmata	FACU	FACU	FACU	3	FACU	Violaceae
Viola pedata	FACU	FACU	UPL	5	UPL	Violaceae
Viola pedatifida	facu	FACU	FACU	3	FACU	Violaceae
Viola pubescens	FACU	FACU	FACU	3	FACU	Violaceae
Viola sagittata	FACW	FAC	FAC	0	FAC	Violaceae
Viola sororia	FAC	FAC	FAC	0	FAC	Violaceae
Viola striata	FACW	FACW	FACW	-3	FACW	Violaceae
VIOLA TRICOLOR	upl	upl	upl	5	UPL	Violaceae
Viola viarum	FACU	FACU	FACU	3	FACU	Violaceae
VITEX NEGUNDO	UPL	UPL	UPL	5	UPL	Lamiaceae
Vitis aestivalis	FACU	FACU	FACU	3	FACU	Vitaceae
Vitis cinerea	FAC	FACW	FACW	3	[FACU]	Vitaceae
VITIS LABRUSCANA	FAC	FACU	FACU	3	FACU	Vitaceae
Vitis palmata	FACW	FACW	OBL	-5	OBL	Vitaceae
Vitis riparia	FACW	FACW	FACW	-3	FACW	Vitaceae
Vitis rotundifolia	FAC	FAC	fac	0	FAC	Vitaceae
Vitis rupestris	UPL	FACU	FACU	3	FACU	Vitaceae
Vitis vulpina	FAC	FAC	FAC	0	FAC	Vitaceae
VULPIA BROMOIDES	UPL	FACW	UPL	5	UPL	Poaceae
Vulpia elliotea	upl	upl	upl	5	UPL	Poaceae
VULPIA MYUROS	FACU	UPL	FACU	3	FACU	Poaceae
Vulpia octoflora var. glauca	FACU	UPL	FACU	3	FACU	Poaceae
Vulpia octoflora var. octoflora	FACU	UPL	FACU	3	FACU	Poaceae
Wisteria frutescens	FACW	FACW	FACW	-3	FACW	Fabaceae
WISTERIA SINENSIS	upl	upl	upl	5	UPL	Fabaceae
Wolffia borealis	OBL	OBL	OBL	-5	OBL	Lemnaceae
Wolffia braseliensis	OBL	OBL	OBL	-5	OBL	Lemnaceae
Wolffia columbiana	OBL	OBL	OBL	-5	OBL	Lemnaceae
Wolffiella gladiata	OBL	OBL	OBL	-5	OBL	Lemnaceae
Woodsia obtusa	upl	upl	upl	5	UPL	Dryopteridaceae
Woodwardia areolata	OBL	FACW	OBL	-3	FACW	Blechnaceae
XANTHIUM SPINOSUM	FACU	FACU	FACU	3	FACU	Asteraceae

Table 3

SCIENTIFIC NAME	AGP	EMP	MW	MO		FAMILY
Xanthium strumarium	FAC	FAC	FAC	0	FAC	Asteraceae
Xyris jupicai	OBL	OBL	OBL	-5	OBL	Xyridaceae
Xyris torta	OBL	OBL	OBL	-5	OBL	Xyridaceae
Yucca arkansana	upl	upl	upl	5	UPL	Agavaceae
Yucca glauca	upl	upl	upl	5	UPL	Agavaceae
YUCCA SMALLIANA	upl	upl	upl	5	UPL	Agavaceae
Zannichellia palustris	OBL	OBL	OBL	-5	OBL	Zanichelliaceae
Zanthoxylum americanum	FAC	FACU	FACU	3	FACU	Rutaceae
ZEA MAYS	upl	upl	upl	5	UPL	Poaceae
ZELTNERA CALYCOSA	FACW	facw	FACW	-3	FACW	Gentianaceae
Zeltnera texensis	upl	upl	upl	5	UPL	Gentianaceae
Zigadenus elegans subsp. glaucus	fac	FAC	FAC	0	FAC	Liliaceae
Zigadenus nuttallii	upl	upl	upl	5	UPL	Liliaceae
ZIZANIA AQUATICA	OBL	OBL	OBL	-5	OBL	Poaceae
Zizania palustris var. interior	OBL	OBL	OBL	-5	OBL	Poaceae
Zizaniopsis miliacea	OBL	OBL	OBL	-5	OBL	Poaceae
Zizia aptera	FAC	FAC	FACU	3	FACU	Apiaceae
Zizia aurea	FAC	FAC	FAC	0	FAC	Apiaceae

Mori, S.A., C. Carollo Matos, Y.-Y. Huang, N.P. Smith, and C. de Moraes Potascheff. 2015. The utility of placentation in the circumscription of genera of new world Lecythidaceae (Brazil nut family). Phytoneuron 2015-13: 1–46. Published 3 March 2015. ISSN 2153 733X

THE UTILITY OF PLACENTATION IN THE CIRCUMSCRIPTION OF GENERA OF NEW WORLD LECYTHIDACEAE (BRAZIL NUT FAMILY)

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ABSTRACT

The utility of placentation in the circumscription of genera of New World Lecythidaceae (Brazil nut family). The placentation of the 16 known clades of New World Lecythidaceae and several species of Old World *Barringtonia* are illustrated and described. The authors conclude that the family possesses axile placentation but an SEM study of flower development may modify that conclusion. They also restrict the term placenta to all tissue derived from the same carpel to which the ovules are attached. The more basal genera are often defined by placental features as well as by morphological apomorphies and sometimes by molecular data. In contrast, *Eschweilera* and *Lecythis*, based on molecular data, are made up of three and five different clades, respectively. Of the three *Eschweilera* clades, the *Eschweilera tetrapetala* clade can be separated from the two other clades of the genus by having more than one row of ovules per locule. In contrast, the other two clades of *Eschweilera* (the *E. integrifolia* and *E. parvifolia* clades) posses a single row of ovules in each locule. We conclude that placental data support the segregation of the *E. tetrapetala* clade as a separate genus while the segregation of the latter two clades is not supported by placental data, even though morphological data support their separation at some taxonomic level. Within the currently circumscribed *Lecythis*, the *Lecythis pisonis*. and *L. corrugata* clades are supported by weak placental data; nevertheless, morphological and molecular data support recognizing them as distinct genera. The *Lecythis ollaria* clade, which includes the type species, is supported by morphological and molecular (100% bootstrap support) data and, if *Lecythis* were restricted to this clade, the genus would be reduced from 26 to three species. In contrast, the *L. poiteaui* and *L. chartacea* clades recovered in this study are not supported by placental or molecular data and morphological support

for these clades is weak. The *Bertholletia excelsa* clade is supported by placental, morphological, and molecular data but retaining it as a monotypic genus, recognizing the *L. ollaria* clade as a genus with three species, and segregating the *L. poiteaui* and *L. chartacea* clades into separate genera await further phylogenetic study because there is poor r6esolution among the clades of these groups of *Lecythis*. Although there may be additional placental features that help define genera, we conclude that they will only be accurately defined if serial sections and SEM developmental sequences are used in future studies. Finally, the relationship between New World and Old World Lecythidaceae through *Grias* is supported by placentation features that do not occur in other New World Lecythidaceae but that are present in species of *Barringtonia*.

Thompson (1921, 1927) was the first to use medial sections of flowers to show the structure and development of the androecium of New World Lecythidaceae and illustrated the placentation of selected actinomorphic- and zygomorphic-flowered species. His carefully prepared drawings illustrate placentation of species of the following genera: *Barringtonia*, *Grias*, *Cariniana* (as species of *Couratari*), *Couratari* (as species of *Lecythopsis*), *Couroupita* , and *Bertholletia*, which represent genera as circumscribed by Prance and Mori (1979) and Mori and Prance (1990). In addition, he studied *Lecythis zabucajo* Aubl., which belongs to the *L. pisonis* Cambess. clade of *Lecythis* as suggested by Huang et al. (in press), and *Asteranthos brasiliensis* Desf., which is now placed in the Scytopetalaceae (Tsou 1994; Appel 1996, 2004).

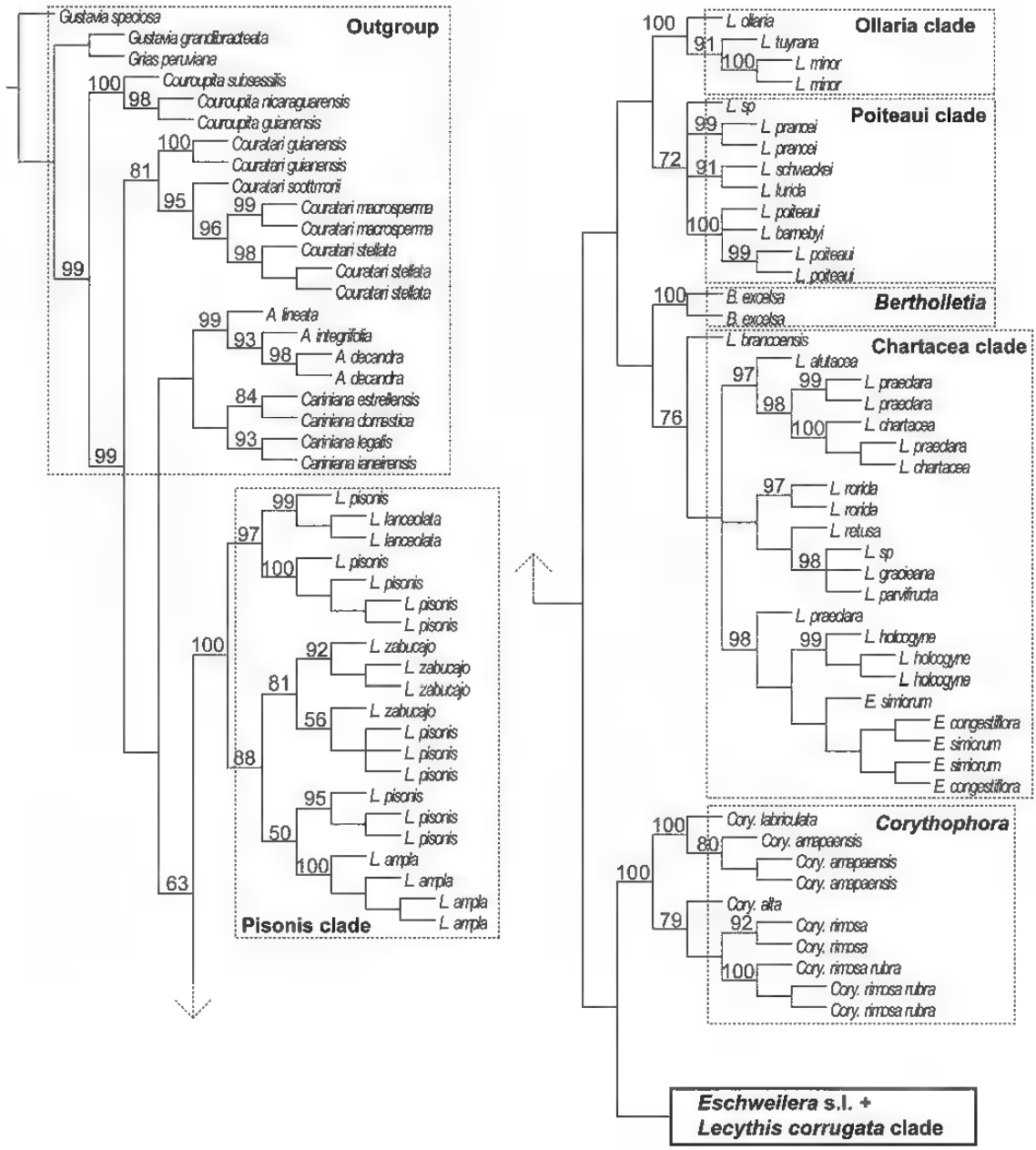
The meticulous studies of fruit development of *Couroupita guianensis* Aubl. published by Schoenberg (1983a, 1983b, 1983c) provide considerable information about placentation of one of the best known species of New World Lecythidaceae.

An important step forward in the knowledge of the placentation of Lecythidaceae was made by Tsou (1994) in her worldwide review of its embryology and the relationship of embryological features with reproductive morphology and systematics. This study also provided outstanding images of the placentation that show similarities of some Old World species with some New World species. For example, species of Old World *Abdulmajida* (placed in *Barringtonia* by Prance 2010, 2012), *Planchonia*, and *Barringtonia* possess placentae that are similar to those of the New World *Grias*, and the placentation of *Careya arborea* Roxb. is similar to some species of New World *Gustavia* (Tsou 1994). The pendulous ovules at the apex of the locules of the erstwhile *Abdulmajidia* are consistent with the transfer of its species into *Barringtonia*. In addition, Tsou and Mori (2007) studied androecial development, provided SEM images and images of sections of pickled flowers, and discussed the development of the ovaries of New World Lecythidaceae.

In contrast, Tsou's (1994) images of the placentation of the Old World *Foetidia oblique* Blume, *Petersianthus quadrialatus* Merr., and *Napoleonaea imperialis* P. Beauv. do not appear to have similarities with taxa of New World Lecythidaceae. A more detailed comparison between the placentation of Old World and New World Lecythidaceae might provide data that could shed light on the relationships between New and Old World genera of the family.

In spite of previous studies, placentation characters have been infrequently used for defining genera and preparing phylogenetic analyses of Lecythidaceae. Their main use has been in keys, but this has been limited to locule number and the type of placentae in *Couroupita guianensis*. On the hand cotyledon development is useful for distinguishing some taxa; i.e., in some genera the cotyledons are leaf-like (*Cariniana*, *Couroupita*, and *Couratari*), in another they are fleshy and irregular (*Gustavia*), and in the remaining genera there are no apparent cotyledons (*Bertholletia*, *Corythophora*, *Eschweilera*, *Grias*, and *Lecythis*) (Prance & Mori 1979, 1983; Mori & Prance 1990).

The purpose of the present study has been to determine the following for New World Lecythidaceae (1) type of placentation (axile or parietal), (2) nature of the placenta, (3) use of placentation features in the generic classification of New World Lecythidaceae, (4) use of placentation features in the clades recognized by Huang et al. (in press) and Mori et al. (in press), and (5) recommendations of the clades that we judge to be stable and those that might have to be recognized as separate taxa in the future. An example of a stable genus with distinct placentation features is *Grias* and of the latter is *Lecythis* (as defined by Prance & Mori 1979; Mori & Prance1990).



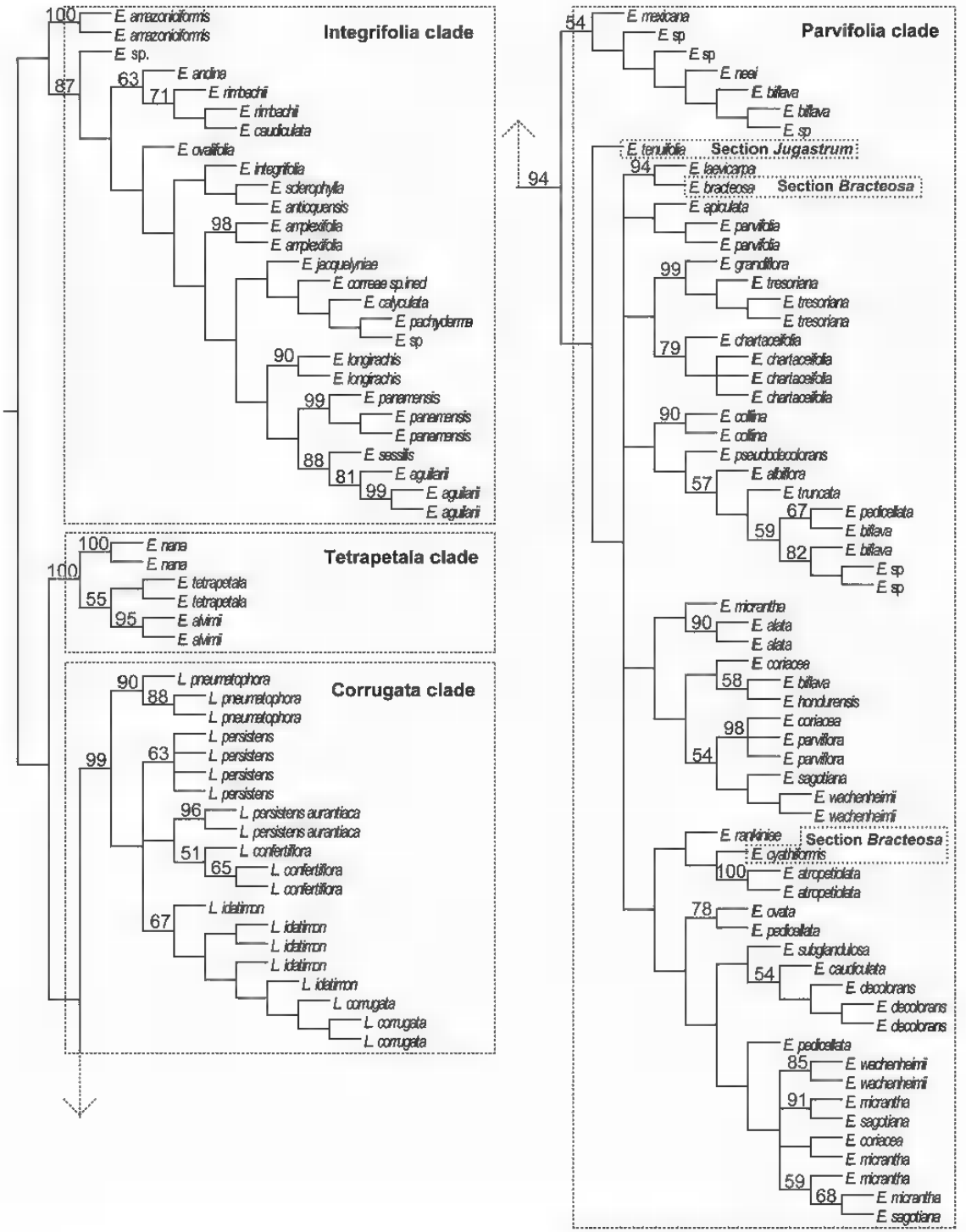


Figure 1A–1B. This cladogram represents a strict consensus of 66 most parsimonious (MP) trees based on total evidence. Bootstrap values (>50%) are given above the branches. The cladogram consists of the outgroup, the non-*Bertholletia* clades (*Gustavia*, *Grias*, *Couroupita*, *Cariniana*, *Allantoma*, *Couratari*) and the *Bertholletia* clades (*Lecythis pisonis*, *L. ollaria*, *Bertholletia excelsa*, *L. poiteaui*, *Corythophora*, *Eschweilera integrifolia*, *E. tetrapetala*, *L. corrugata*, and *Eschweilera parvifolia* clades). This figure was taken from Huang (2010).

Figure 1 provides an overview of the non-*Bertholletia* clade based on molecular data (Mori et al. 2007) and for the *Bertholletia* clade based on both molecular and morphological data (Huang 2010). Images of placental features are provided in Figures 2–26. Because of the difficulty in understanding the morphological features used to distinguish the clades of New World Lecythidaceae, we recommend reading and studying the plates of the clades in Huang et al. (in press) and Mori et al. (in press). The terminology used to describe Lecythidaceae can also be consulted on the Lecythidaceae Pages (Mori et al. 2010 onward).

METHODS

Buds from the pickled (usually in 50% or 70% ETOH) collection of Lecythidaceae at The New York Botanical Garden (NY) and from fresh flowers were hand sectioned in cross- and longitudinal sections (Figs. 3, 4). If pickled material was not available, buds from herbarium specimens were sectioned after being boiled in water with a few drops of detergent until they were soft. In many cases, buds are so damaged in the collecting process that they do not yield informative sections, especially if they are dried with too much pressure and heat. In contrast, buds that have been slowly dried in paper bags outside of the press usually assume their original form after boiling in water with several drops of dishwashing detergent. Each of the collections sectioned is vouchered by a herbarium collection listed in the figure legends. Those collections with specimens at The New York Botanical Garden are not indicated with the NY acronym while those archived in other herbaria are indicated by the acronyms of where they are stored (Thiers, 2014 onward).

The best results from cross-sections (Fig. 3) were obtained just below the apex or of the placentae—a section made at the very apex of the locule may not show the manner in which the ovules are inserted on the placenta and might not even show the septa joining at their inner apices. Likewise, a section at the base of the ovary might cut through a space in which there are no ovules. It is, however, useful to know if the ovules are attached all of the way along the placenta to the base of the locule. A longitudinal section that removes the outer wall of a locule was made to determine the number of columns and rows and the position of ovules on the placenta (Figs. 6–7). In addition a medial longitudinal section, cut down the middle of the ovary (this section should cut at least part of the style), was made to show the relationship of the placenta with the septum as well as the way the upper septum articulates with the lower septum (Fig. 2).

It is extremely difficult to section buds that are comparable with one another because it is hard to select buds that are at the same developmental stage and to make hand sections at the same location of the ovary. For these reasons, we only used characters that we evaluated as not changing significantly in spite of different bud sizes and different positions of the sections. Thus, we do not report absolute lengths and shapes but relate the size of a structure as a percentage of a larger structure (e.g., the length of the lower septum as a percentage of the overall length of the lower/upper septum. For example, Fig. 4I shows an upper septum longer than the lower septum, Figure 4G shows a lower septum longer than the upper septum, and Fig. 2K shows lower and upper septa equal in length. Other clades seem to lack upper septa (Fig. 4A, E, H) but these may have arms that extend upward from the lower septum along the stylar canal (Figs. 2J).

We sectioned a small number of flowers compared to the numbers of flowers found on an individual tree, on different individuals in a population, and on individuals from other populations Unfortunately, almost all characters vary to some extent; thus, a species with a 4-locular ovary almost always produces some flowers with 3- and 5-locular ovaries—and this varies within and between individuals. The greatest difficulty in circumscribing plant taxa is determining how much morphological (including placental) and molecular data variation is allowed before populations of individuals are assigned to a different taxon. All studies suffer, at least to some extent, because of small sample size.

The Huang et al. (in press) and the Mori et al. (in press) papers provide descriptions and plates of the morphological features of the 15 clades of New World Lecythidaceae currently recovered. The cladograms upon which this paper is based are found in Huang et al. (in press). Reading these papers in conjunction with this paper facilitates understanding of how placentation features relate to the generic classification of New World Lecythidaceae. A major problem with the most recent morphological and molecular analyses of Lecythidaceae is that many of the clades within the Bertholleita and non-Bertholletia clade are not resolved (Huang 2010; Huang et al., in press; Mori et al. 2007, in review) and it is likely that the resolution of the clades included in the currently circumscribed *Eschweilera* and *Lecythis* (Mori & Prance 1990) may change in such a way that splitting these two taxa into additional genera may not be justified. Therefore, we only recommend segregating the clades recovered in the most recent molecular studies (Huang et al., in press; Mori et al. 2007) into genera if the clades are strongly supported by both molecular and morphological data.

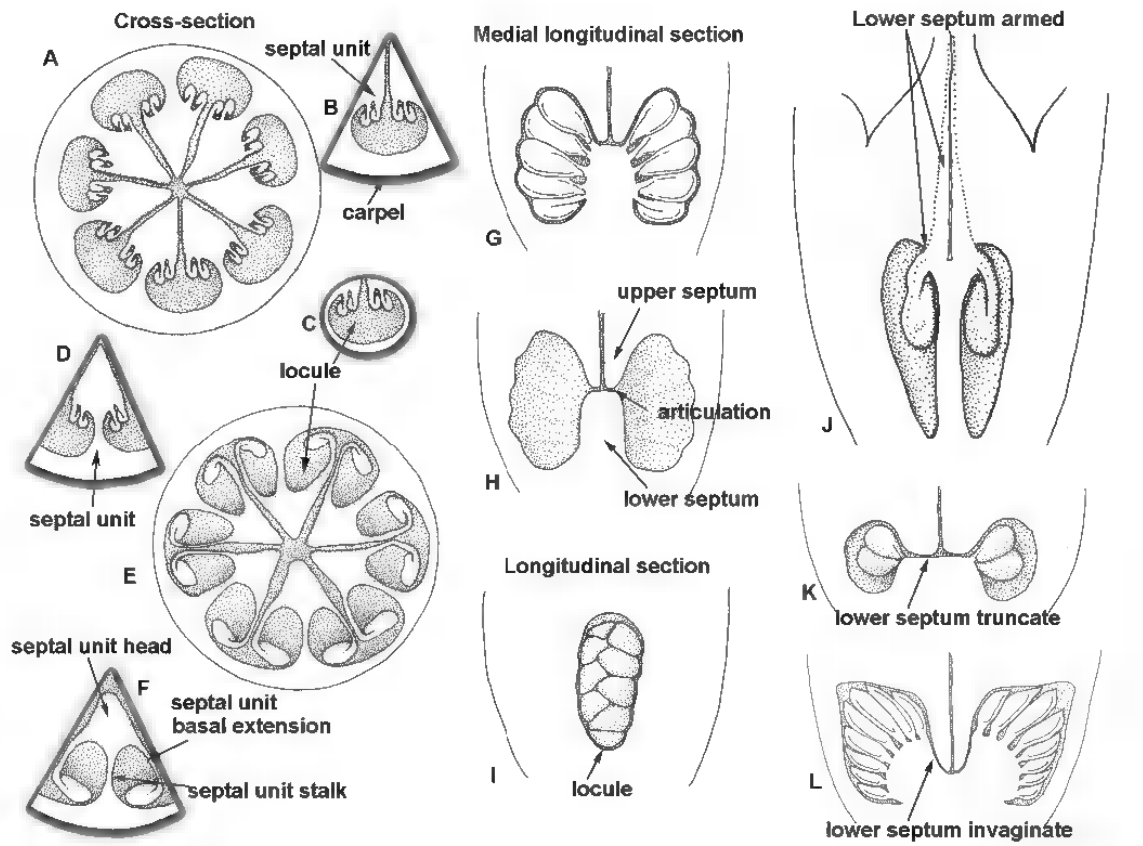


Figure 2. General placentation terms. A. Cross-section of an ovary with the septal units spear-shaped. B. One of seven carpels of the ovary illustrated in the preceding drawing. C. One of the six locules of the ovary as indicated by the arrow. D. One of the seven septal units of the ovary illustrated in the preceding drawing. Note that a septal unit consists of tissue from adjacent carpels. E. Cross-section of an ovary with long septal unit head basal extensions. F. One of the seven septal units illustrated in the A. G. Medial longitudinal section. Note that this type of section goes through the middle of the ovary and, thus, usually cuts at least part of the style (not visible here). H. The same as G but with the ovules removed. Note the upper and lower septa and the articulation between them. I. Longitudinal section that does not go through the middle of the ovary and only cuts off the outside of the ovary wall. This type of section is good for determining the number of rows and columns of ovules per locule. J. An armed lower septum. In species with this type of septum the upper septum is poorly developed or absent. K. A truncate lower septum possessing a flat apex. L. An invaginate lower septum in which the upper septum appears to push into the lower septum.

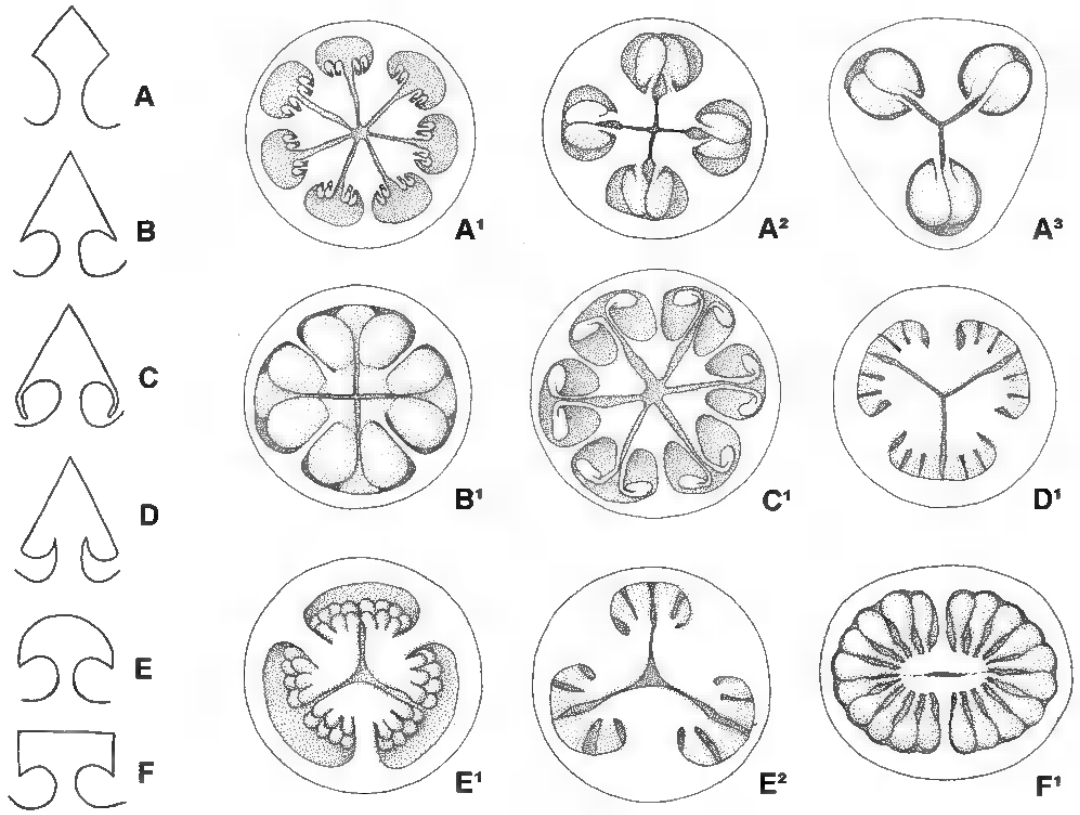


Figure 3. Septal unit heads as seen in cross-section. A. Spear-shaped septal unit head. A^1–A^3. Cross-sections of ovaries showing examples of spear-shaped septal unit heads. B. Arrowhead-shaped septal unit head. B^1. Cross-section of an ovary showing arrowhead-shaped septal unit heads with poorly developed septal unit basal extensions. C. Arrowhead-shaped septal unit head with well-developed septal unit basal extensions. C^1. Cross-section of an ovary with very long septal head basal extensions. D. Arrowhead-shaped septal unit head with thick basal extensions. D^1. A Cross-section of an ovary showing thick septal unit basal extensions. E. Anchor-shaped septal unit head. E^1–E^2. Cross-section of an ovary showing anchor-shaped septal unit heads. F. Anvil-shaped septal unit head. F^1. Cross-section of an ovary showing anvil-shaped septal unit heads.

RESULTS

In this section, we describe the placentation of the clades of Lecythidaceae as defined in Huang et al. (in press) and Mori et al. (in review) and summarize support for the clades based on molecular (Fig. 1) and morphological (Figs. 2–25) data. The clades are presented in alphabetic order. If a cited figure is found in another publication the reference to it is preceded by "see." For example "(see Fig. 21 in Huang 1990)."

***Allantoma* clade** (Fig. 7)

Ovary (3)4-locular. Septal units as seen in cross-section through placentae: spear-shaped (B–C). Locule orientation and width as seen in longitudinal section: vertical (E), width intermediate (E). Lower septum: truncate at apex (E), occupying ca. 50% of upper/lower septum length (E). Placentae as seen in longitudinal section: narrow columnar (E). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, ca. 10–18 per locule, in 2 columns (B, C) and 5-8 rows, (D–E), inserted along most of length of lower septum, with short ovule-free area below ovule insertion (E).

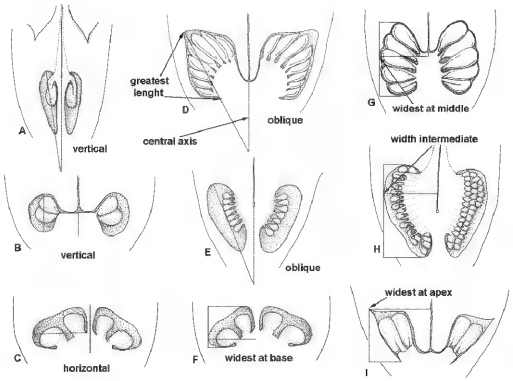


Figure 4. Locule orientation seen in medial longitudinal section. A. Vertically oriented locules. B. Vertically oriented locules. C. Horizontally oriented locules. D. Obliquely oriented locules. E. Obliquely oriented locules. F. Locules widest at base. G. Locules widest at middle. H. Locules with intermediate width (between the middle and apex of the locule). I. Locules widest at apex.

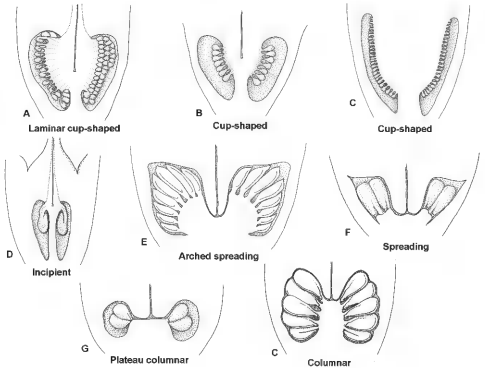


Figure 5. Placentation types as seen in medial longitudinal section. A. Laminar cup-shaped (e.g., in the *Couroupita* clade). B–C. Cup-shaped (in the *Gustavia* clade). D. Incipient (in the *Grias* clade). E. Arched spreading (e.g., in the *Couratari* clade). F. Spreading (e.g., in the *Corythophora, Eschweilera, Lecythis chartacea and Lecythis corrugata* clades). G. Plateau columnar (e.g., in the *Bertholletia excelsa* clade). H. Columnar (e.g., in the *Allantoma, Cariniana, Lecythis pisonis, and Lecythis poiteaui* clades).

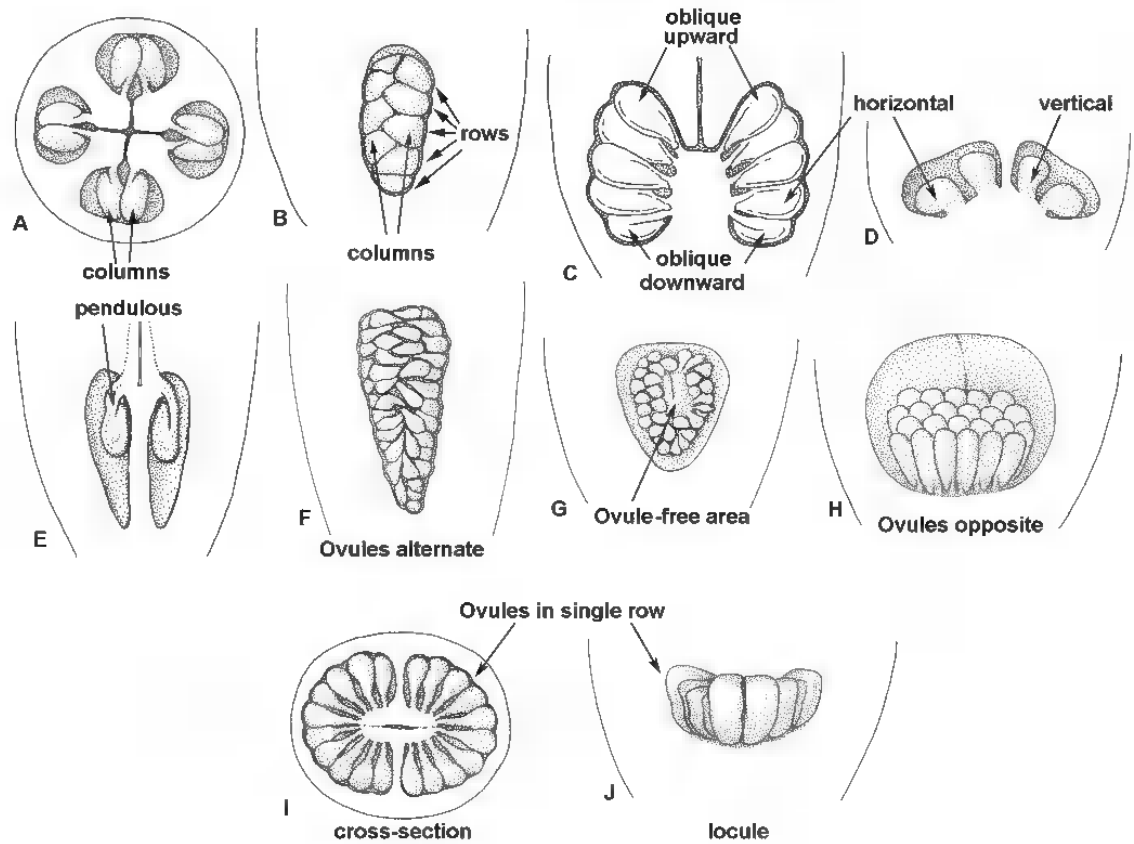


Figure 6. Ovule attachment and orientation as seen in cross and longitudinal sections. A. Cross-section showing ovules in 2 columns. B. Longitudinal section showing ovules in 1–2 columns and 5 rows. The ovules are alternately arranged. C. Medial longitudinal section showing the upper ovules oriented obliquely upward, some of the middle ovules oriented horizontally, and the lower ovules oriented obliquely downward. D. Longitudinal section showing vertically and obliquely upward oriented ovules. E. Medial longitudinal section showing pendulous ovules (a feature restricted to species of *Barringtonia* and *Grias*). F. Longitudinal section showing numerous, alternately arranged ovules. G. Longitudinal section showing an ovule-free area in the middle (found in some species of *Gustavia*. H. Longitudinal section showing ovules in 6 columns and 4 rows. I. Cross-section showing the ovules in ca. 10 columns and a single row (a feature restricted to the *Eschweilera integrifolia* and *Eschweilera parviflora* clades). J. Longitudinal section showing the ovules in 6 columns and a single row per locule.

Barringtonia clade (Fig. 8)

Ovary 4-locular. Septal units as seen in cross-section through placentae: arrowhead-shaped (B) or spear-shaped (G), the basal extensions thick (B) or absent (G). Locule orientation and width as seen in longitudinal section: vertical (D, I–J), width intermediate (D, I). Lower septum: truncate? or slightly arched? at apex, occupying 100% of lower/upper septum length (D–E, I–J). Placentae as seen in cross- and longitudinal sections: incipient (D–E, I–J). Ovules as seen in cross- and longitudinal sections: mostly pendulous (D–E, I–J), sometimes horizontal (D, apical row), not flattened, ca. 2–5 per locule, in 2 columns (B–C and 1 row (D–E, I–J); inserted at apex of lower septum, with long ovule-free area below ovule insertion (Figs. D–E, I–J).

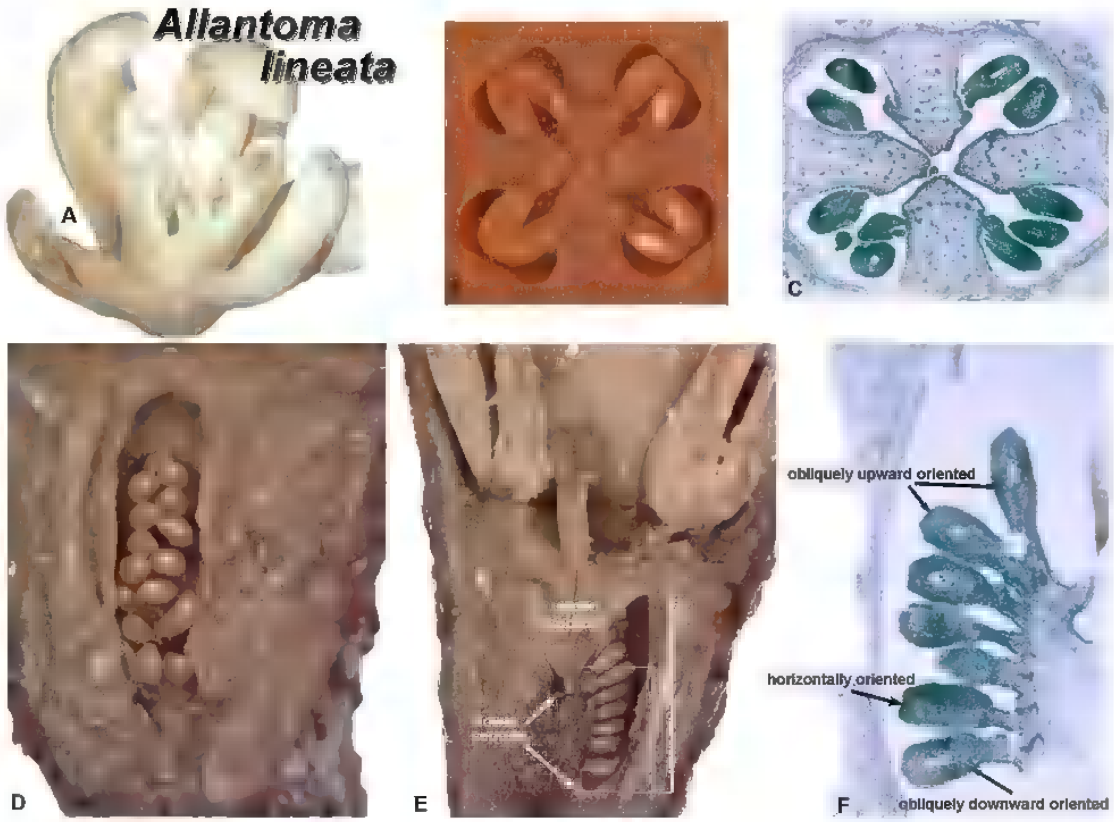


Figure 7. *Allantoma* clade. A. *Allantoma integrifolia* (Ducke) S.A. Mori, Y.-Y. Huang & Prance. B–F. *Allantoma lineata*. A. Flower. B. Cross-section of an ovary showing 2 columns of ovules per locule. C. Cross-section of an ovary showing spear-shaped septal unit heads. D. Longitudinal section of an ovary showing ca.16 ovules in 2 columns. E. Medial longitudinal section showing the columnar placenta and articulation between the lower and upper septa. F. Longitudinal section of an ovary showing ovule orientation. A. Photo by M. Hopkins based on *PA 89* at INPA. B, D–E. Photos by C.M. C. M. de Potascheff and C. Carollo Matos based on *Freitas 521*. F. Photos by C. Carollo Matos based on *Prance 17549*.

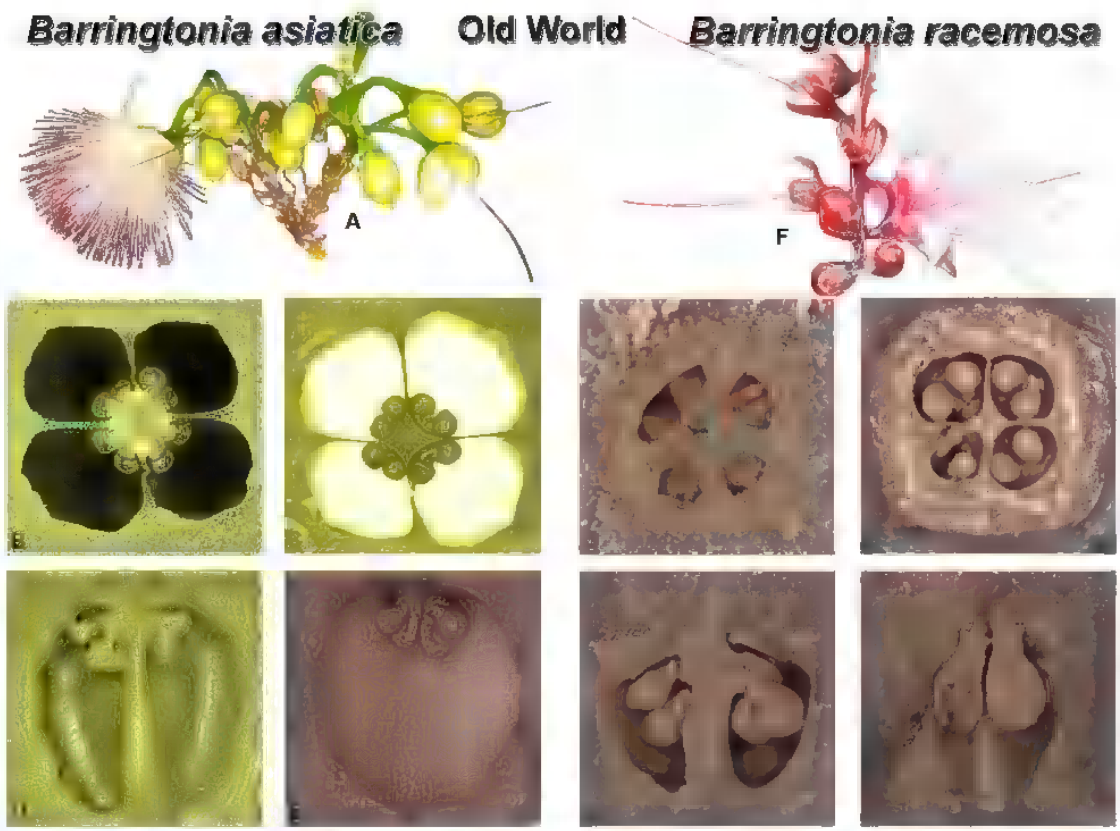


Figure 8. *Barringtonia* clade. A–E. *Barringtonia asiatica* (L.) Kurz. F–J. *Barringtonia racemosa* (L.) Sprengel. A. Part of an inflorescence showing buds and an open flower. B. Cross-section of an ovary (apical view) showing arrowhead-shaped septal unit heads and thin septal head stalks. C. Cross-section of an ovary (basal view) showing 4 locules. D. Medial longitudinal section of an ovary showing 2 locules with pendulous ovules. E. Longitudinal section of an ovary showing a locule with 4 ovules attached to the incipient placentae. F. Part of an inflorescence showing buds, an open flower, and 2 flowers that have lost their petals. G. Cross-section of an ovary (apical view) above point of ovule attachment. H. Cross-section of an ovary (basal view) showing pendulous ovules and arrowhead-shaped septal unit heads. I. Longitudinal section of an ovary showing the pendulous ovules attached at the apex of the lower septum and the incipient placentae. J. Longitudinal section of an ovary showing a locule with 2 pendulous ovules. A. Photo by Mori based on *Mori et al. 25013* (collection is a photograph only). B–E. Photo by C. Carollo Matos based on an unvouchered collection by an unknown collector from Indonesia. F. Photo by C.A. Gracie based an unvouchered tree cultivated at the Royal Botanic Gardens, Kew. G–J. Photos by C. Carollo Matos based on an unvouchered collection by C.-H. Tsou in Sri Lanka.

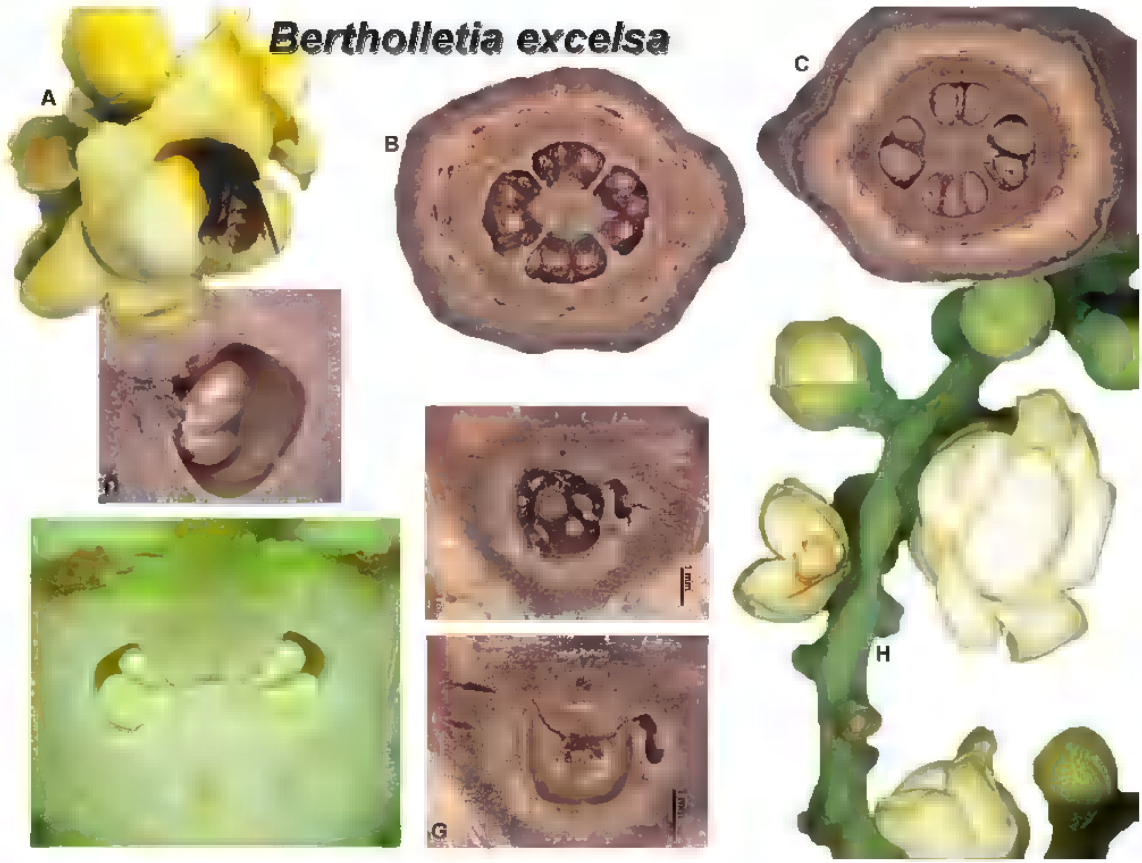


Figure 9. B*ertholletia excelsa* clade. A–H. *Bertholletia excelsa*. A. Flowers and buds. B. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads. C. Cross-section of an ovary (basal view) showing the 4 locules of this species. D. Longitudinal section of an ovary showing the ovule attachments. E. Medial longitudinal section showing the columnar plateau placentae and the truncate apex of lower septum. F. Longitudinal section of an ovary showing a locule and some of the ovules. G. Ovules removed from locule to show funicular scars. H. Part of an inflorescence. A. Photo by A.J. Henderson based on *J.F. Ramos P20205*. B–D, F. Photos by C. Carollo Matos based on *Freitas 511* (assumed to be at INPA). E. Photo by N.P. Smith based on *N.P. Smith 397* (at INPA). H. Photo by Mori based on *Mori et al. 17503*.

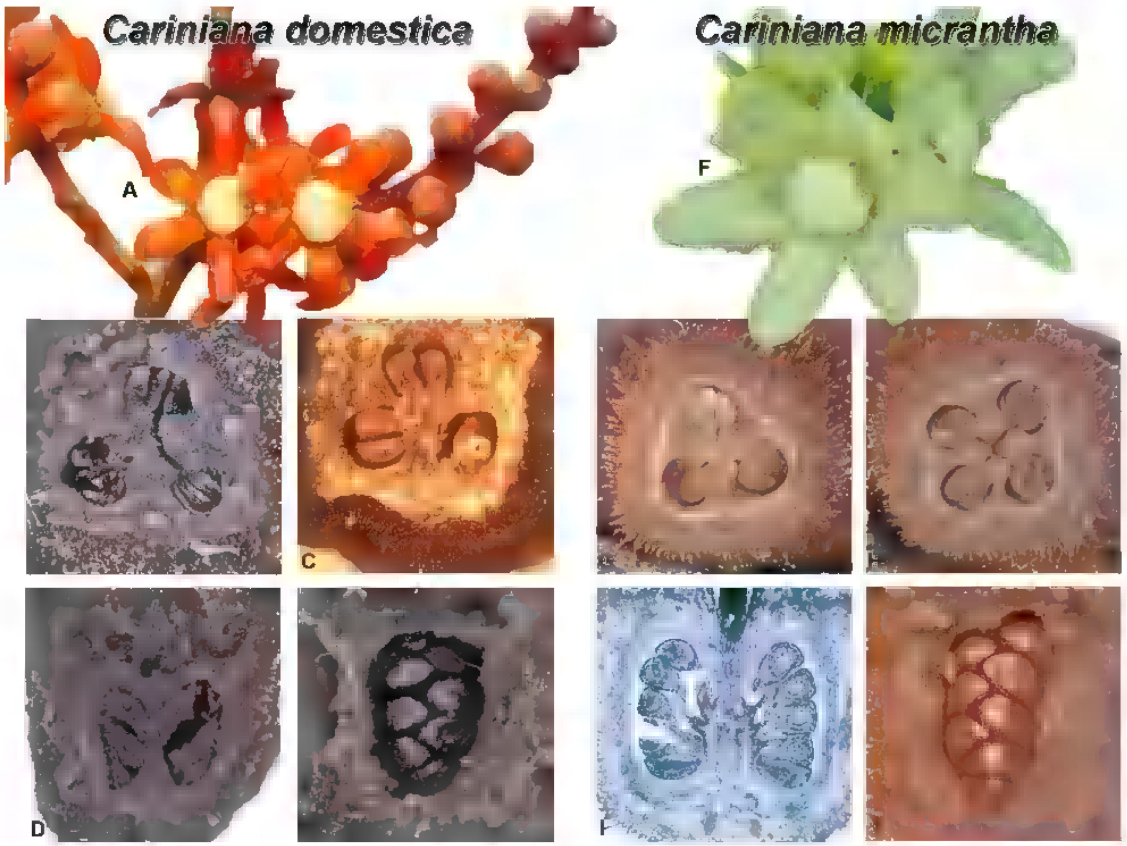


Figure 10. *Cariniana* clade. A–E. *Cariniana domestica* (Mart.) Miers. F–J. *Cariniana micrantha* Ducke. A. Flowers and buds. B. Cross-section of an ovary (apical view) showing the spear-shaped septal unit heads. C. Cross-section of an ovary (basal view) showing 3 locules and 2 columns of ovules. D. Longitudinal section of an ovary of *Cariniana domestica* showing lower septum and ovule orientations. E. Longitudinal section of an ovary showing a locule and alternately arranged ovules. F. Flowers. G. Cross-section of an ovary (basal view) showing the spear-shaped septal unit heads, 3-locular ovary, and 2 columns of ovules. H. Cross-section of an ovary (basal view) showing 4-locular ovary from same collection as in G. with a 3-locurlar ovary. I. Medial longitudinal section of an ovary showing the columnar placentae and ovules extending nearly along the full length of the lower septum. J. Longitudinal section of an ovary showing alternately arranged ovules. A. Photo by M. Nee based on *Nee 58876*. B, D–E. Photos by C. Carollo Matos based on *Prance et al. 7967*. C. Photo by N.P. Smith based on *Prance et al. 8834*. F. Photo by Mori based on *Mori 20191*. G–J. Photos by C. Carollo Matos based on *Mori 20191*.

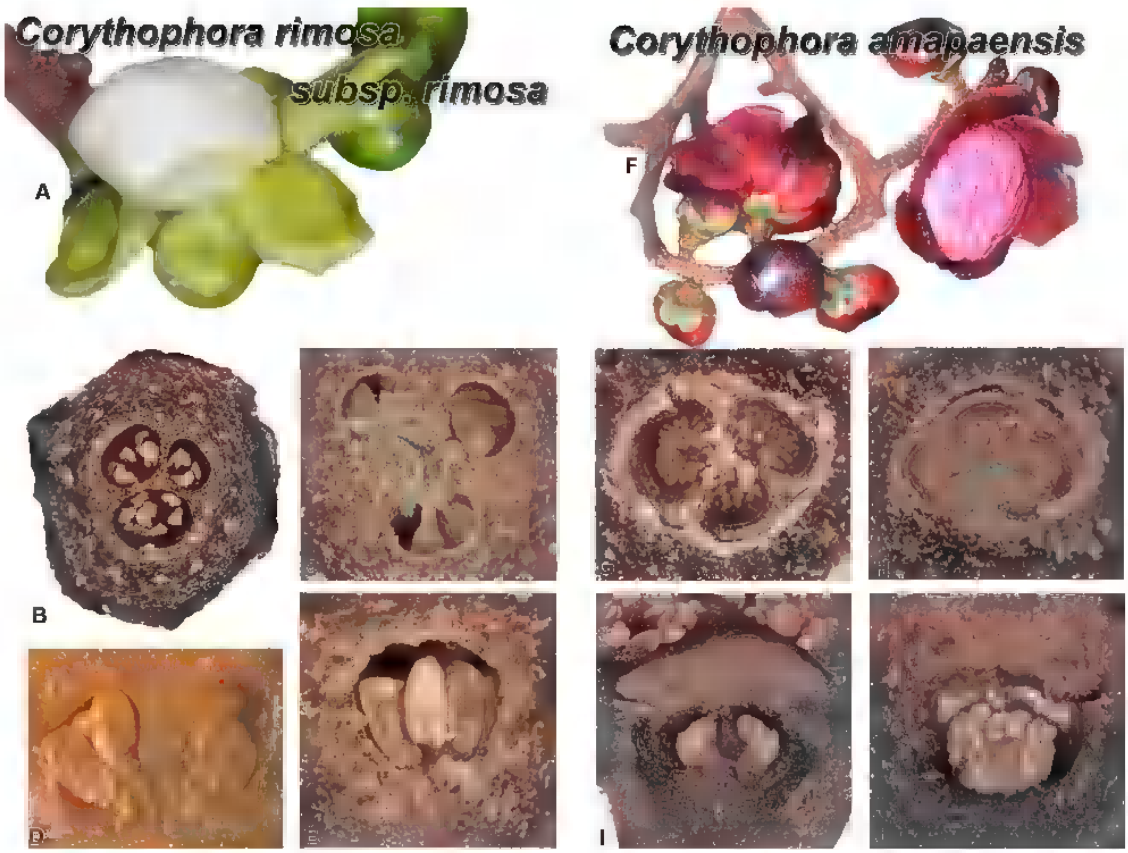


Figure 11. *Corythophora* clade. A–E. *Corythophora rimosa* W. Rodrigues subsp. *rimosa*. F–J. *Corythophora amapaensis* Pires ex S.A. Mori & Prance. A. Flower and buds. B. Cross-section of an ovary (apical view) showing 3 locules. C. Cross-section of an ovary (basal view) showing anchor-shaped septal unit heads. D. Medial longitudinal section of an ovary showing the spreading placentae. E. Longitudinal section of an ovary showing the attachment of the ovules and the spreading placenta. F. Flower and buds. G. Cross-section of an ovary (apical view) showing 3 locules and numerous ovules. H. Cross-section of an ovary (apical view) showing the anchor-shaped septal unit heads. I. Medial longitudinal section of an ovary showing the spreading placentae. J. Longitudinal section of an ovary showing the attachment of the ovules. A. Photo by M.J.G. Hopkins based on *Smith & Hopkins 367* (at INPA). B–C, E. Photos by C. Carollo Matos based on Prance et al. 10417. D. Photo by C.M.de Potascheff based on *Mori & Pereira 20525*. F. Photos by C. Gracie based on *Mori et al. 22640*. G–J. Photos by C. Carollo Matos based on *Mori et al. 18550*.

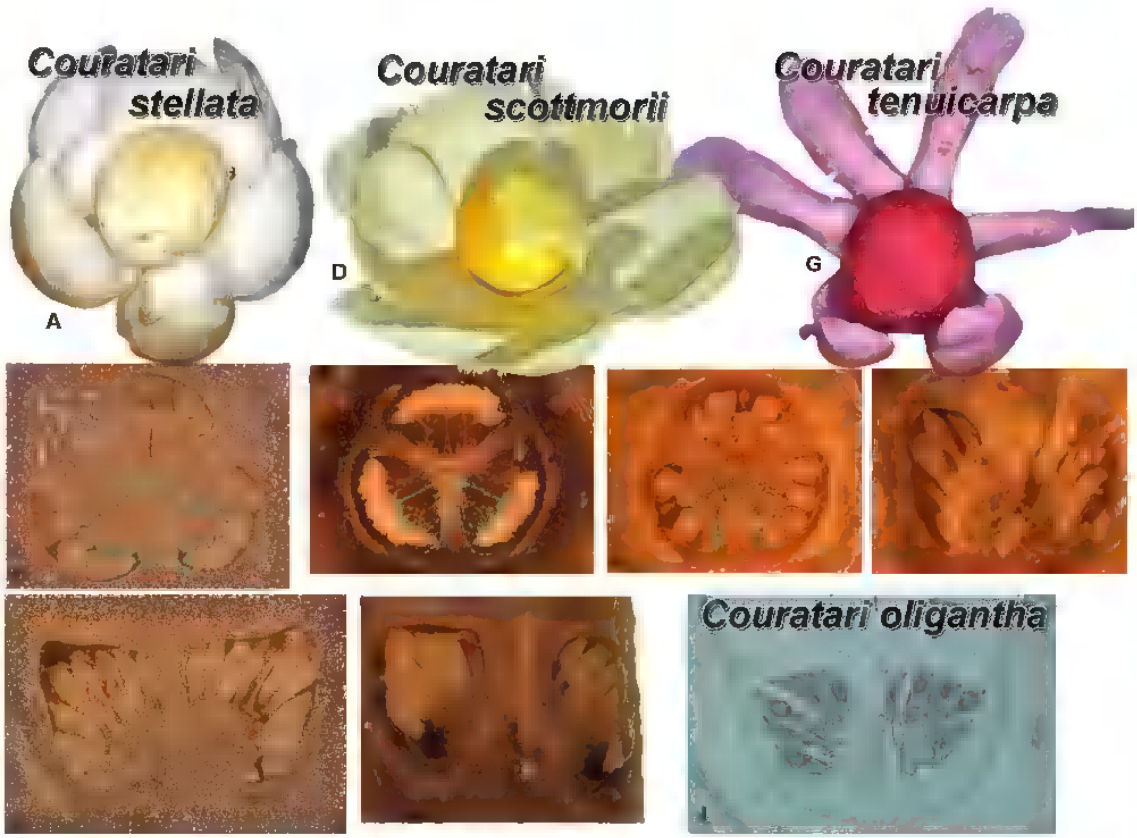


Figure 12. *Couratari* clade. A–C. *Couratari stellata* A.C. Sm. D–F. *Couratari scottmorii* Prance. G–I. *Couratari tenuicarpa* A.C. Sm. J. *Couratari oligantha* A.C. Sm. A. Flower. B. Cross-section of an ovary (basal view) showing the arrowhead-shaped septal unit heads, the thick septal unit head basal extensions, and the 3-locular ovary. *C.* Longitudinal section of an ovary showing the placentae arched spreading. D. Flower. E. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads, the thick septal unit head basal extensions, and the 3-locular ovary. F. Medial longitudinal section of an ovary showing the placentae arched spreading and invaginated lower septum. G. Flower. H. Cross-section of an ovary (basal view) showing the arrowhead-shaped septal unit heads, the thick septal unit head basal extensions, and the 3-locular ovary. I. Longitudinal section of an ovary showing the placentae arched spreading and invaginated lower septum. J. Medial longitudinal section of an ovary showing the flattened ovules. A. Photo by C. Gracie based on *Mori et al. 22750*. B–C. Photos by C.M. C. M. de Potascheff based on *Prance et al. 22900*. D. Photo by R. Aguilar based on *Aguilar 10259*. E–F. Photo by N.P. Smith based on pickled flowers of *Cornejo 8043* (from same tree as *Aguilar 11108* at CR). G. Photo by C. Gracie based on an unvouchered tree. H–I. Photos by N.P. Smith based on *Mori et al. 20331*. J. Photo by C. Carollo Matos based on *Plowman 12546*.

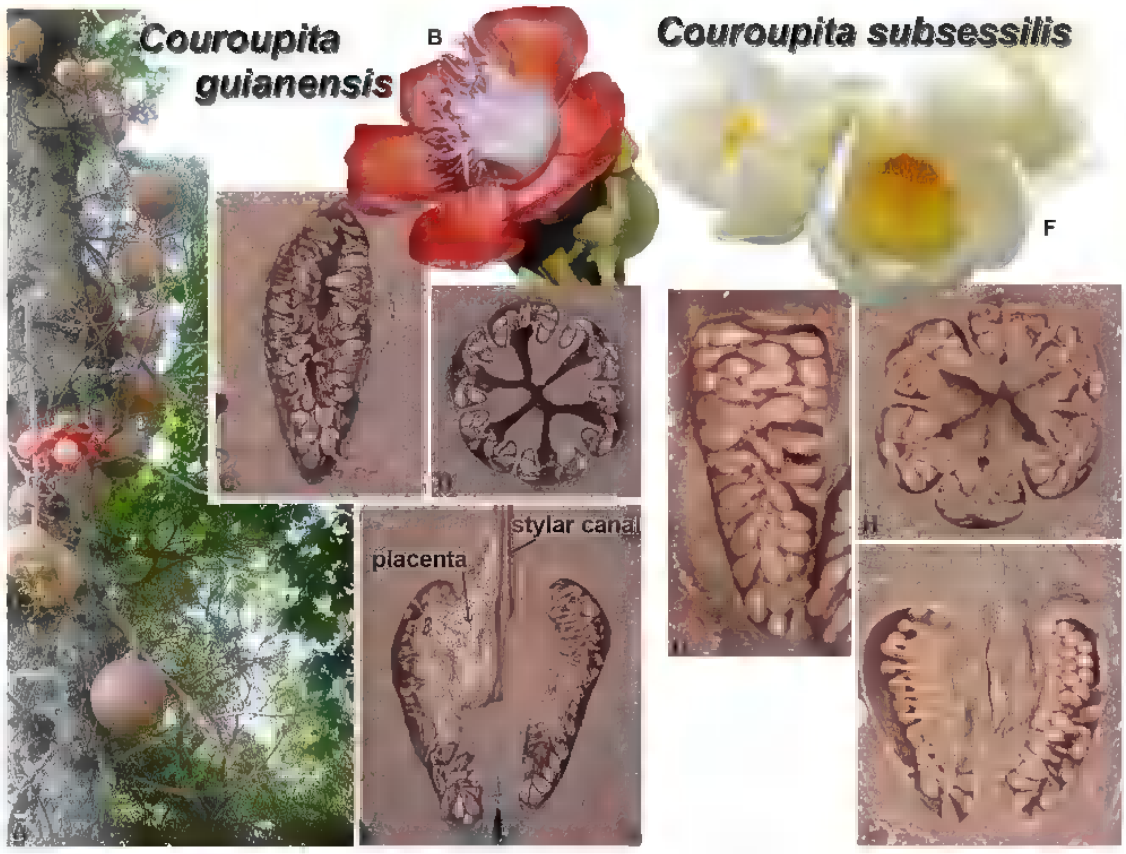


Figure 13. *Couroupita* clade. A–E. *Couroupita guianensis*. F–I. *Couroupita subsessilis*. A. Tree bearing fruits and flower on the trunk. B. Flower. C. Longitudinal section of an ovary showing the locule and numerous ovules with many rows. D. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal heads and the long septal head basal extensions. E. Medial longitudinal section of an ovary showing the placentae laminar cup-shaped. F. Flowers. G. Longitudinal section of an ovary showing the locule and numerous alternately arranged ovules. H. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads and the long septal head basal extensions. I. Medial longitudinal section of an ovary showing the laminar placentae laminar cup-shaped. A. Photo by S. Zona based on an unvouchered tree. B. Photo by R. Aguilar based on *R. Aguilar 13743* (at CR). C–E. Photos by C. Carollo Matos based on an unvouchered pickled collection made by C–H. Tsou from the Fairchild Tropical Garden, Florida, USA. F. Photo by M. Geschneider based on an unvouchered plant cultivated in the conservatory of the University of Ulm, Germany. G–I. Photos by C. Carollo Matos based on *Lleras 16883* from Amazonas, Brazil.

Figure 14. *Eschweilera integrifolia* clade. Plate 1: A—G. *Eschweilera integrifolia*. A. Flower. B. Cross-section of an ovary (apical view) showing the 2-locular ovary each with a single row of ovules. C. Cross-section of an ovary (apical view) showing the anvil-shaped septal unit heads. D. Cross-section of an ovary (basal view) with the ovules removed and showing the upper septum (= above the placentae) and the septal articulations. E. Cross-section of an ovary (basal view) showing the lower septum and the anvil-shaped septal unit. F. Medial longitudinal section showing the spreading placentae. G. Medial longitudinal section showing the invaginate lower septum. A. Photo by X. Cornejo based on *Cornejo & Bonifaz 8018*. B–G. Photos by C. Carollo Matos based on *Cornejo & Bonifaz 8018*.

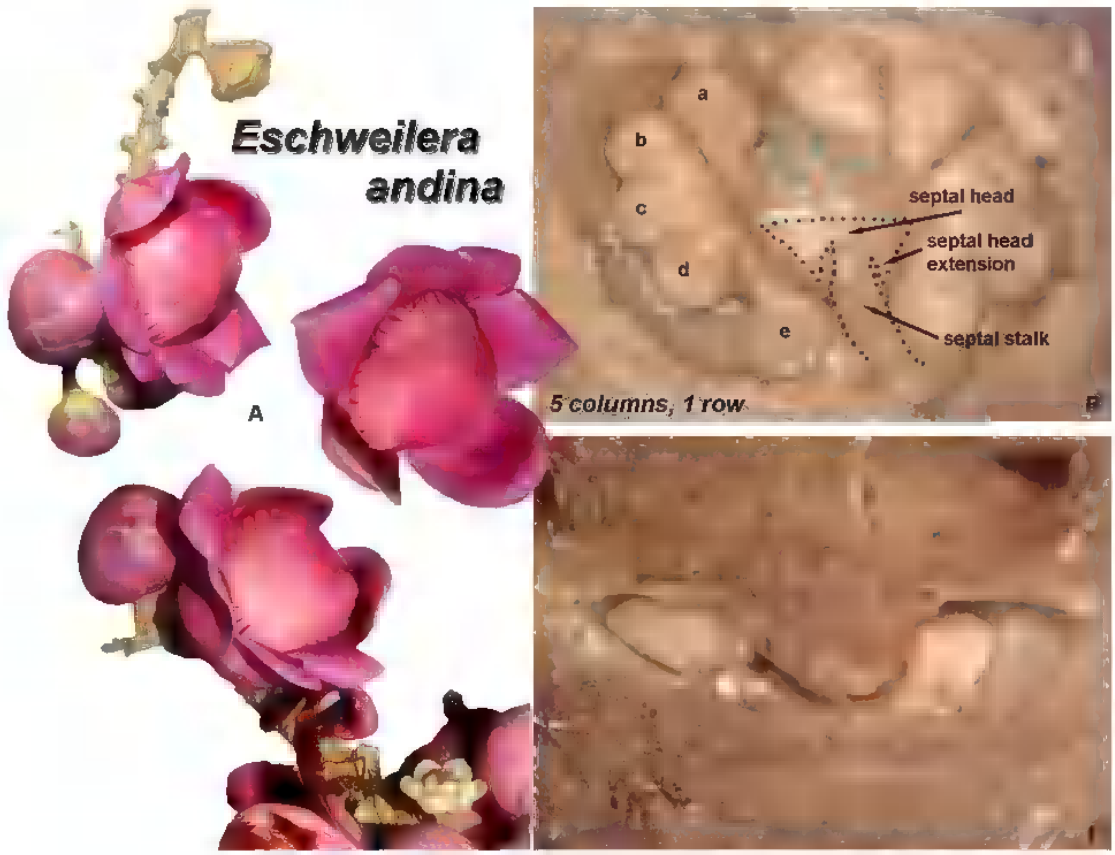


Figure 15. *Eschweilera intregrifolia* clade. Plate 2: A—C. *Eschweilera andina* (Rusby) J.F. Macbr. A. Buds, flowers, and very young fruit. B. Cross-section of an ovary (apical view) showing the anvil-shaped septal unit heads. C. Longitudinal section of an ovary showing the spreading placentae and invaginated lower septum. A. Photo by C. Davidson based on *Araujo-Murakami 1110* from La Paz, Bolivia. B–C. Photo by C. Carollo Matos based on *Pitman 5892* from Napo, Ecuador.

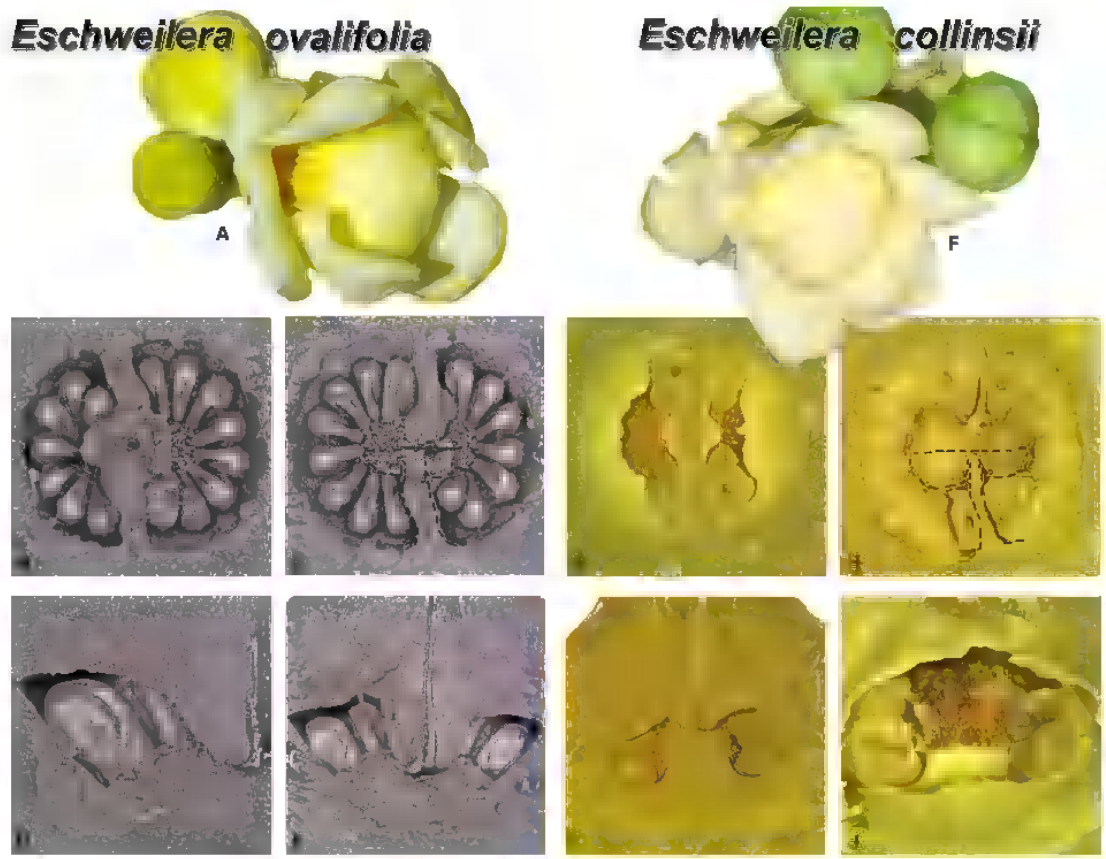


Figure 16. *Eschweilera integrifolia* clade. Plate 3: A—E. *Eschweilera ovalifolia* (DC.) Nied. F—J. *Eschweilera collinsii*. A. Flowers and buds. B. Cross-section of an ovary (apical view) showing lower part of the upper septum. C. Cross-section of an ovary (apical view) showing the anvil-shaped septal unit heads. D. Medial longitudinal section showing the obliquely upward oriented ovules. E. Medial longitudinal section of an ovary showing the invaginate lower septum and the spreading placentae. F. Flower and buds. G. Cross-section of an ovary (apical view) through upper septum showing 2-locular ovary. H. Cross-section of an ovary (apical view) showing the anvil-shaped septal unit heads. I. Medial longitudinal section of an ovary showing columnar placentae and the space between the base of the lower septum and the attachment of the ovules. J. A few ovules removed from locule to show funicular scars. A. Photo by T.L.P. Couvreur based on *Couvreur 240* from La Paz, Bolivia. B–E. Photos by C. Carollo Matos based on *Prance et al. 24390*. F. Photo by R. Aguilar based on *R. Aguilar 8857* (at CR). G–J. Photos by C. Carollo Matos based on *Mori & Kallunki 3172*.

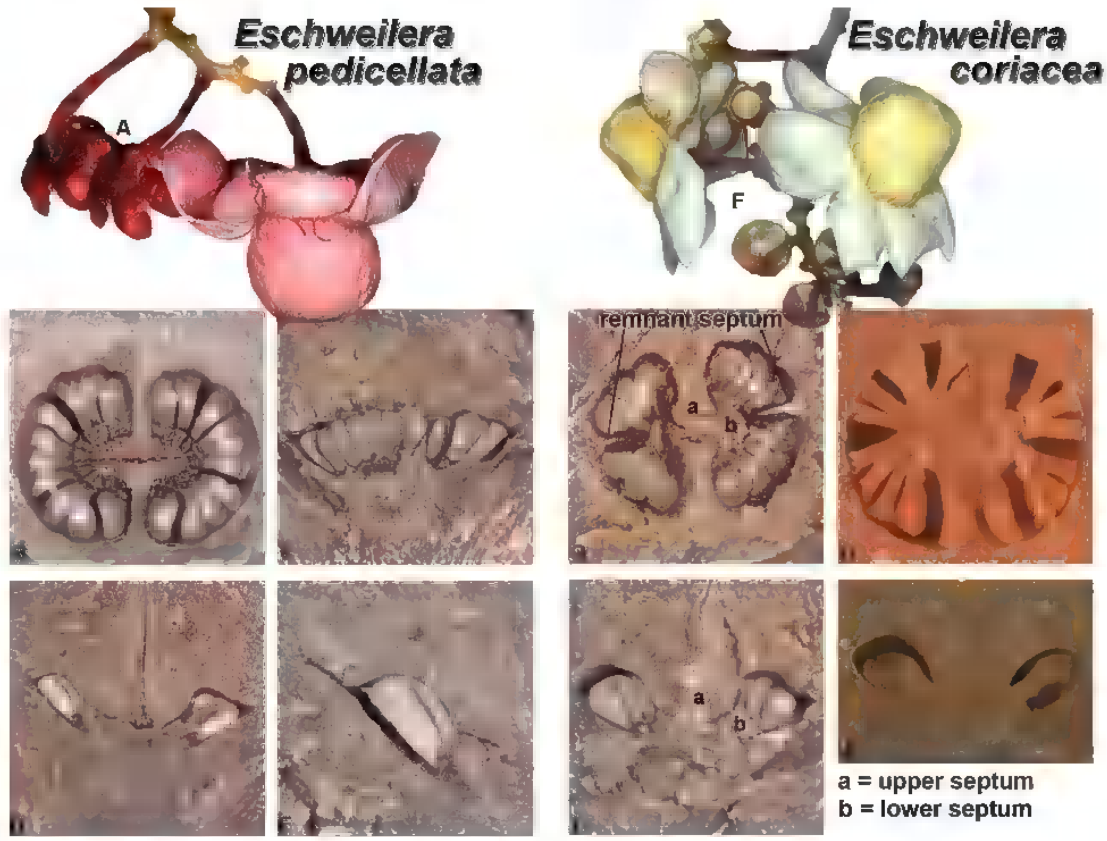


Figure 17. *Eschweilera parvifolia* clade. A–E. *Eschweilera pedicellata* (Rich.) S.A. Mori. F–J. *Eschweilera coriacea* (DC.) S.A. Mori. A. Flower and immature fruits. B. Cross-section of an ovary (apical view) showing anvil-shaped septal unit heads. C. Longitudinal section of an ovary showing the single rows of ovules. D. Medial longitudinal section of an ovary showing spreading placentae. E. Medial longitudinal section showing obliquely upward oriented locule and ovules. F. Flowers and buds. G. Cross-section of an ovary (apical view) showing remnant septum indicating that 2-locular ovaries may have evolved from an ancestor with 4-locular ovaries. H. Cross-section of an ovary (basal view) showing anvil-shaped septal unit heads. I. Medial longitudinal section of an ovary showing the spreading placentae and the slightly invaginate lower septum. J. Longitudinal section of an ovary showing the spreading placentae. A. Photo by Mori based on *Mori et al. 25648*. B–E. Photos by C. Carollo Matos based on *N. Cunha 389*. F. Photo by C.A. Gracie based on *Mori et al. 22651*. G, I. Photos by C. Carollo Matos based on *Cunha 452*. H, J. Photos by C.M. de Potascheff based on *Prance et al. 22837*.

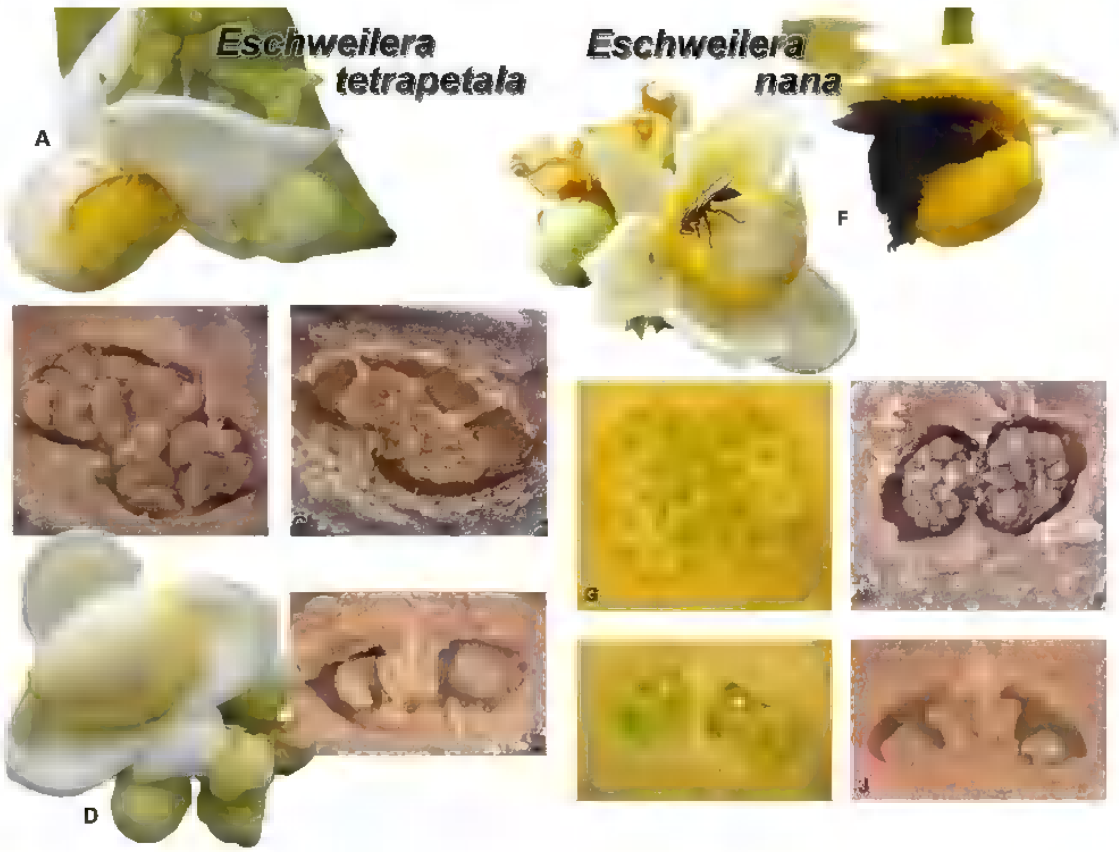


Figure 18. *Eschweilera tetrapetala* clade. A–E. *Eschweilera tetrapetala.* F–J. *Eschweilera nana* (O. Berg) Miers. A. Lateral view of flower. B. Cross-section of an ovary (apical view) showing more than a single row of ovules in each locule. C. Cross-section of an ovary (apical view) showing the placenta with the ovules removed. D. Apical view of flower and buds. E. Medial longitudinal section of an ovary showing the spreading placentae. F. Flower being visited by a non-pollinating hymenoptera (left) and a large *Centris scopipes* bee pollinator visiting a flower (right). G. Cross-section of an ovary (apical view) showing 4–5 columns of ovules. H. Cross-section of an ovary (apical view) showing more than on row of ovules. I. Longitudinal section of an ovary showing spreading placentae and 2—3 rows of ovules. J. Longitudinal section of an ovary showing locule widest at the base. A, D. Photos by N.P. Smith based on *N.P. Smith et al. 116*. B–C, E. Photos by C.M. de Potascheff based on *Hatschbach & Kummrow 48060*. F, G, I. Photos by C.M. de Potascheff based on *C..M. de Potascheff 001*. H. Photo by C. Carollo Matos based on *Anderson 36667*. J. Photo by C.M. de Potascheff based on *Maguire et al. 56555*.

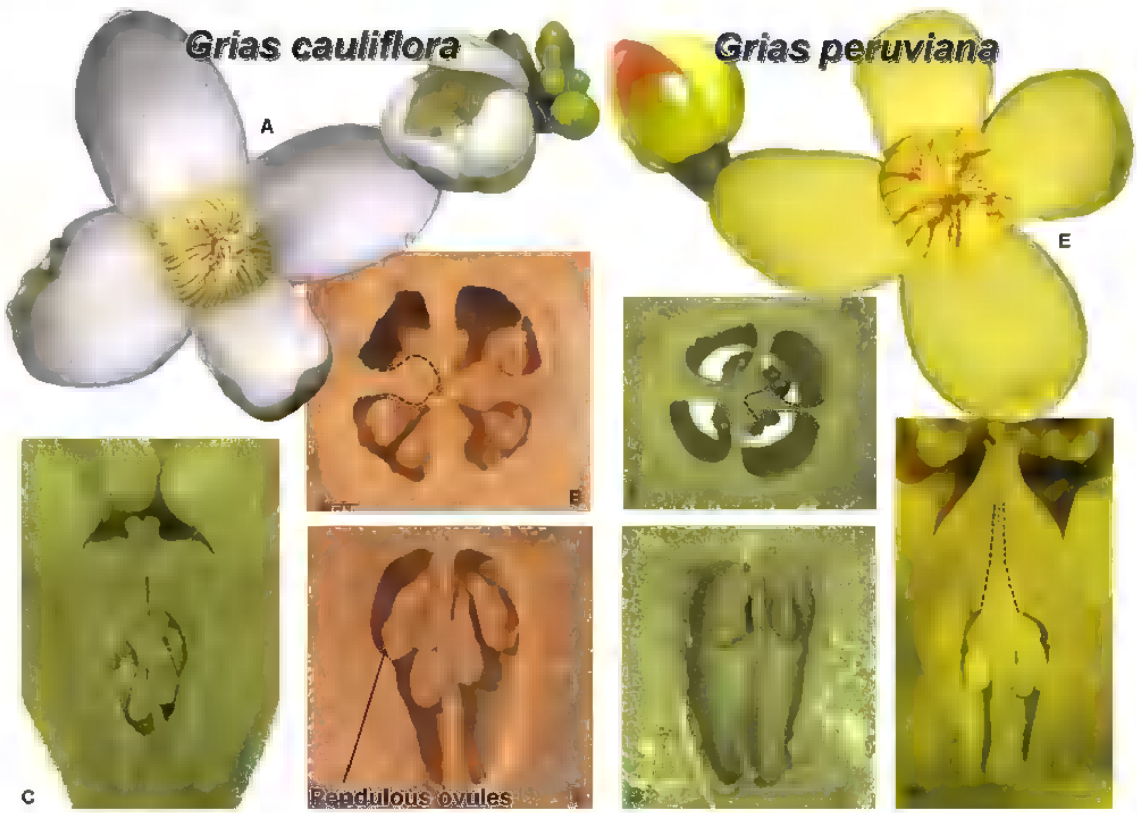


Figure 19. *Grias* clade. A–D. *Grias cauliflora* L. E–H. *Grias peruviana* Miers. A. Flowers and buds. B. Cross-section of an ovary (apical view) showing the spear-shaped septal unit heads. C. Medial longitudinal section of an ovary showing the pendulous ovules and the incipient placentae. D. Longitudinal section of an ovary showing the pendulous ovules and the long ovule-free area between the base and apex of the lower septum. E. Flower and bud. F. Cross-section of an ovary (apical view) showing the spear-shaped septal unit heads, 4 locules, and the thin septal stalks. G. Longitudinal section of an ovary showing the pendulous ovules and the long ovule-free area between the base and apex of the lower septum. H. Medial longitudinal section of an ovary showing the incipient placentae and the faint outline of the armed lower septum. A. Photo by L. Raz based on *L. Raz 400* (at FTG). B–D. Photos by C.M. de Potascheff based on *Nee & Mori 3574*. E. Photo by X. Cornejo based on *Cornejo & C. Medina 8220*. F. Photo by C. Carollo Matos based on *C. Peters 84-55*. H. Photo by X. Cornejo based on *C. Peters 84-55*.

Figure 20. *Gustavia* clade. A–E. *Gustavia dubia* (Kunth) O. Berg. F–J. *Gustavia grandibracteata* Croat & S.A. Mori. A. Flower and immature fruit. B. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads. C. Longitudinal section of the ovule attachments in three locules. D. Medial longitudinal section of an ovary showing the laminar cup-shaped placenta. E. Close-up of the preceding showing the outward and downward orientation of the ovules. F. Flowers. G. Cross-section of an ovary (apical view) showing the spear-shaped septal unit heads not fused at the apex of the ovary. H. Cross-section of an ovary (basal view) showing the fused carpels at the base of the placenta. I. Longitudinal section of an ovary showing the cup-shaped placentae. J. Longitudinal section of an ovary showing the high number of ovule rows per locule. A. Photo by P.M.J. Maas based on *Maas et al. 2801*. B–E. Photos by C. Carollo Matos based on *Mori 7704*. F. Photo by C. Galdames based on *Galdames et al. 9541*. G–J. Photos by C. Carollo Matos based on *Mori & Kallunki 5612*.

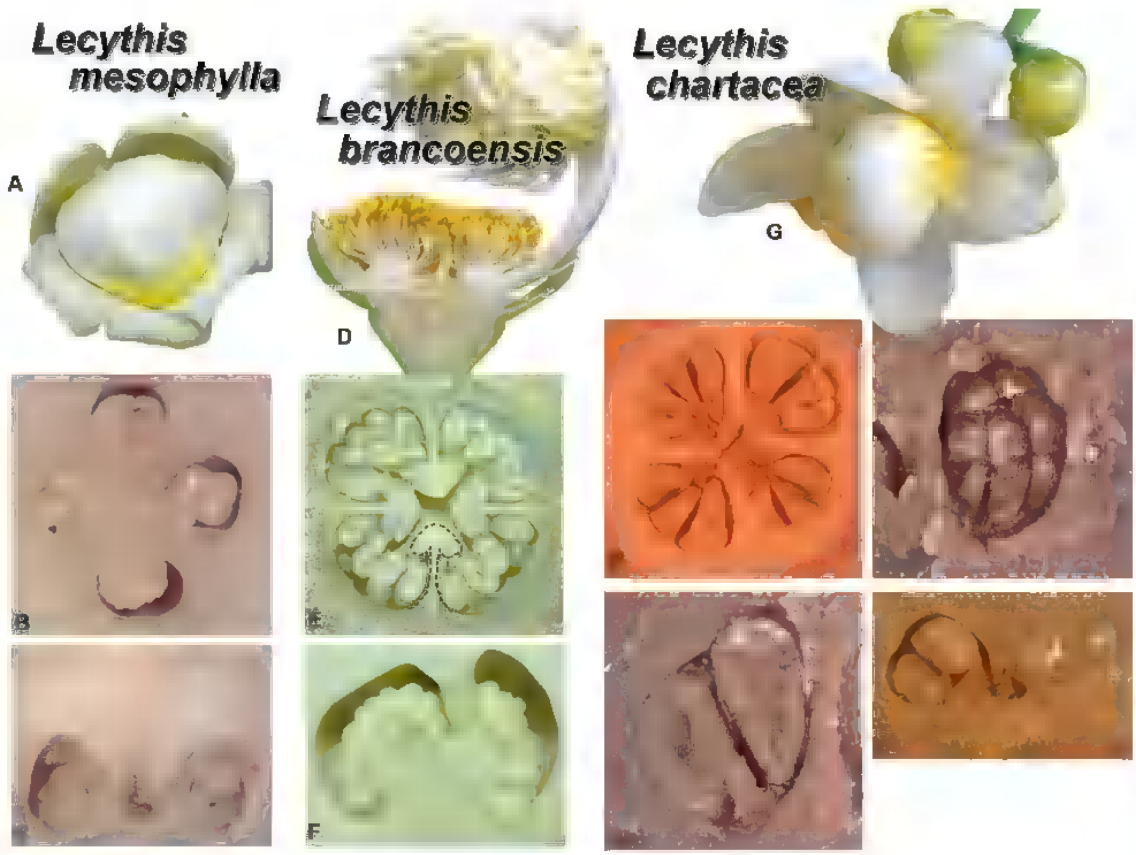


Figure 21. *Lecythis chartacea* clade. A–C. *Lecythis mesophylla* S.A. Mori. D–F. *Lecythis brancoensis*. G–K. *Lecythis chartacea*. A. Flower. B. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads and 4 locules. C. Medial longitudinal section of an ovary showing invaginate lower septum and spreading placentae. D. Medial longitudinal section of a mature bud (with petals removed). E. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads. F. Longitudinal section of an ovary showing the columnar placentae. G. Buds and a flower. H. Cross-section of an ovary (apical view) showing 3 to 4 columns of ovules. I. Longitudinal section of an ovary showing 3 columns and 3 rows of ovules. J. Longitudinal section showing one obliquely upward and outward ovule and one vertically oriented ovule. K. Medial longitudinal section of an ovary showing the spreading placenta and the invaginate lower septum. A. Photo by R. Aguilar based on *Aguilar 13712*. B–C. Photos by C. Carollo Matos based on *Aguilar 1177*. D. Photo by N.P. Smith based on *N.P. Smith 380*. E. Photo by N.P. Smith based on *N.P. Smith 381*. F. Photo by N.P. Smith based on *N P. Smith 379*. G. Photo by C. Bhikhi based on *C.B. Bhikhi 100*. H, K. Photos by C.M. de Potascheff. based on *Berg et al. BG706*. I, J. Photos by C. Carollo Matos based on *Lleras et al. P19664*.

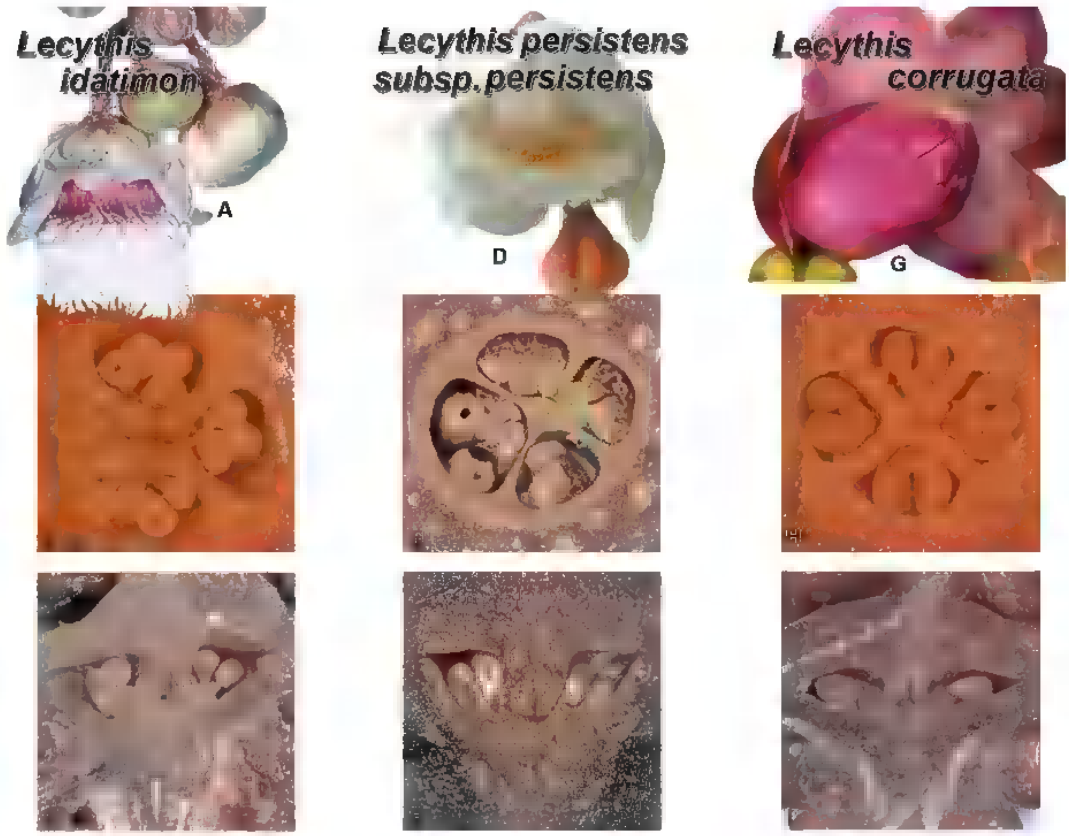


Figure 22. *Lecythis corrugata* clade. A–C. *Lecythis idatimon* Aubl. D–F. *Lecythis persistens* Sagot. G—I. *Lecythis corrugata*. A. Buds and flower. B. Cross-section of an ovary (apical view) showing the 4 locules common to this clade. C. Medial longitudinal section of an ovary showing the spreading placentae and locules wider at apices. D. Flower and bud. E. Cross-section of an ovary (basal view) showing the arrowhead-shaped septal unit heads. F. Medial longitudinal section of an ovary showing the spreading placentae, the locules wider at apices, and the obliquely upward and outward oriented ovules. G. Flower. H. Cross-section of an ovary showing 4 locules and 2–3 columns of locules. I. Medial longitudinal section of an ovary showing the spreading placentae and the invaginate lower septum. A. Photo by Mori based on *Mori et al. 17739* (at IAN). B. Photo by C.M. de Potascheff based on *Prévost & Sabatier 4776*. C. Photo by C. Carollo Matos based on *Prévost & Sabatier 4776*. D. Photo by Mori based on *Mori 25523*. E–F. Photos by C. Carollo Matos based on *Mori & J.J. de Granville 8810*. G. Photo by Mori based on *Mori et al. 25730*. H. Photo by C.M. de Potascheff based on *Tinde van Andel et al. 2636*. I. Photo by C. Carollo Matos based on *Tinde van Andel et al. 2636*.

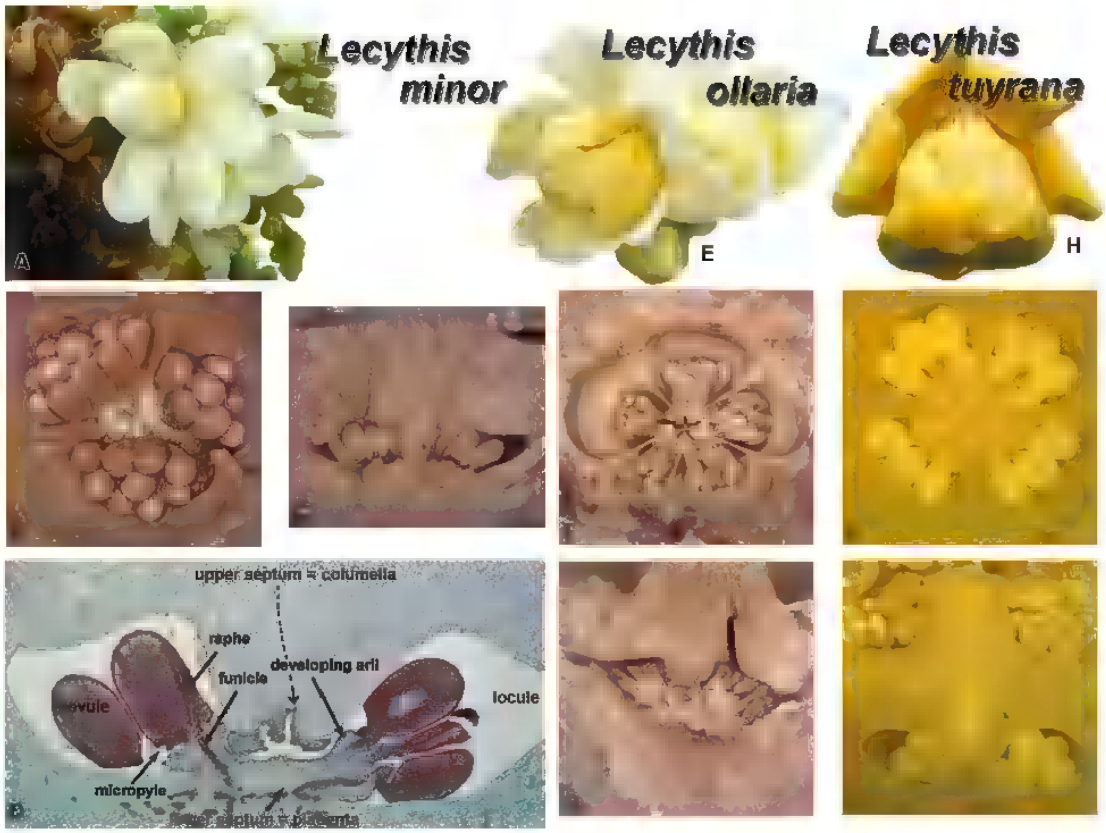


Figure 23. *Lecythis ollaria* clade. A–D. *Lecythis minor* Jacq. E–G. *Lecythis ollaria.* H–J. *Lecythis tuyrana* Pittier. A. Flowers and buds. B. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads. C. Longitudinal section of an ovary showing the spreading placentae and the locules widest at apex. D. Medial longitudinal section of an ovary (microscope slide) showing spreading placentae and invaginate lower septum. E. Flower (the flower has an abnormal split in the androecial hood). F. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit head and thin septal unit stalks. G. Medial longitudinal section of an ovary showing the spreading placentae and locules widest at the apex. H. Flower. I. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads. J. Medial longitudinal section of an ovary showing the spreading placentae. A. Photo by A. de Sedas based on *A. de Sedas 219*. B–C. Photos by C. Carollo Matos based on *Prance et al. 23155*. D. Photo by C. Carollo Matos based on *Nee 7226*. E. Photo by G. Aymard based on *Aymard et al. 12786*. F–G. Photos by C. Carollo Matos based on *Aymard & Ferrera 13088*. H. Photo by Mori based on *Mori & Kallunki 5772*. I–J. Photos by C. Carollo Matos based on *Galdames 5766*.

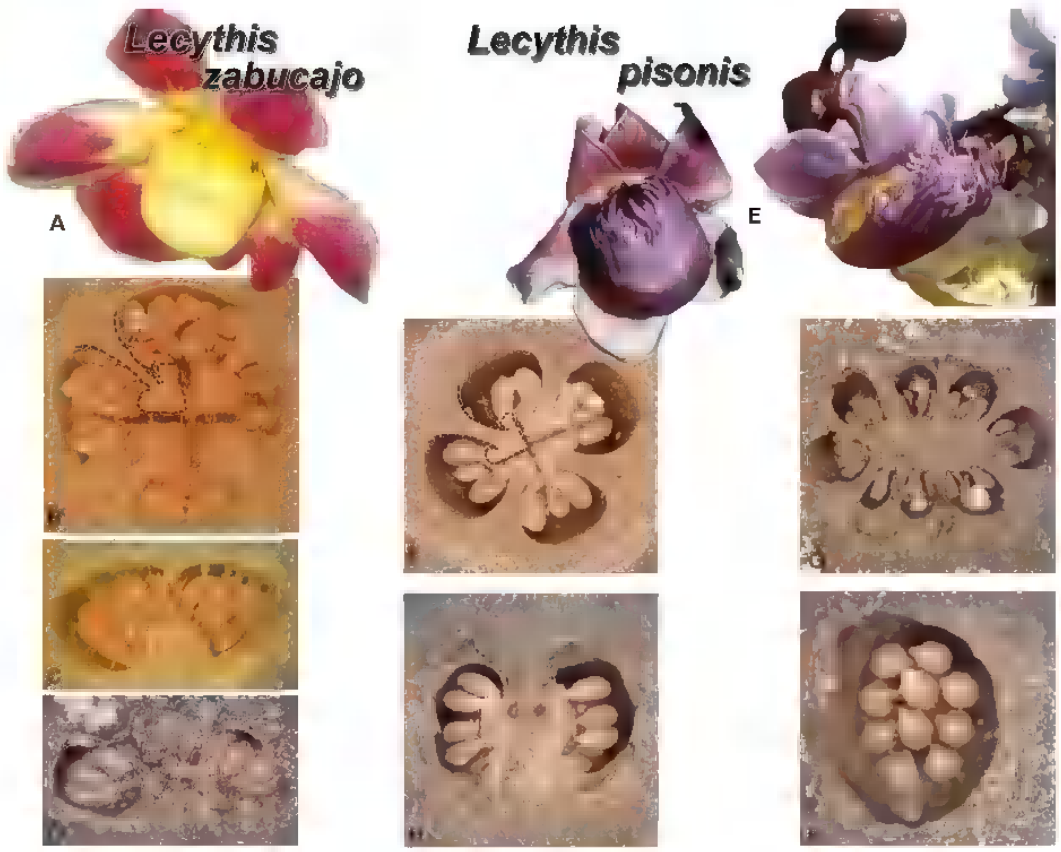


Figure 24. *Lecythis pisonis* clade. A–D. *Lecythis zabucajo*. E–I. *Lecythis pisonis*. A. Flower. B. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads. C. Longitudinal section of an ovary showing the obliquely upward oriented ovules and the columnar placentae. D. Longitudinal section of an ovary showing the truncate lower septum and the ovule orientations. E. Flower and buds. F. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads and 4-locular ovary. G. Cross-section of an unusual 8-locular ovary. H. Longitudinal section of an ovary showing the columnar placentae. I. Longitudinal section showing the ovules attached in 2–3 columns and 4 rows. Note that there is an ovule-free space above and below the ovules. A. Photo by Mori based on *Mori et al. 25034*. B–C. Photos by C.M. de Potascheff based on *Mori et al. 8106*. D. Photo by C. Carollo Matos based on *Mori* & Bolten 8381. E. Photos by Mori (left) based on *Mori et al. 16527* and C.M. de Potascheff (right) based an unvouchered cultivated tree. F–I. Photos by C. Carollo Matos based on *Prance et al. 14730*.

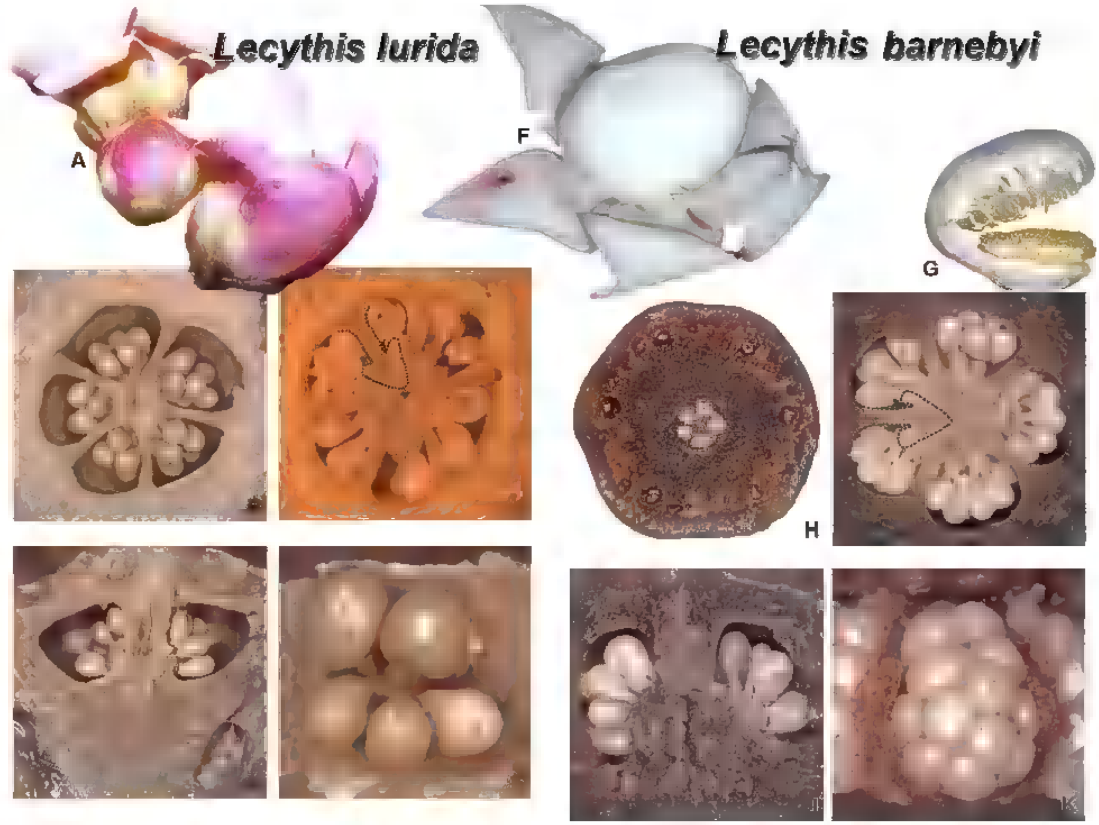


Figure 25. *Lecythis poiteaui* clade. A–E. *Lecythis lurida*. F–K. *Lecythis barnebyi*. A. Flowers and bud. B. Cross-section of an ovary (apical view) showing the arrowhead-shaped septal unit heads. C. Cross-section of an ovary (basal view) showing the arrowhead-shaped septal unit heads. D. Medial longitudinal section of an ovary showing locules widest in the middle and the columnar placenta. E. Longitudinal section of an ovary showing 4 rows of ovules in locule. F. Flower. G. Androecium of flower. H. Cross-section of an ovary (apical view) showing mucilage ducts in the hypanthium. I. Cross-section of an ovary (apical view) showing arrowhead-shaped septal unit heads. J. Medial longitudinal section of an ovary showing columnar placentae. K. Longitudinal section with the outer wall of ovary removed showing up to 4 columns and 5 rows of ovules per locule. A, C. Photos by Mori (A) and N.P. Smith (C) based on *Mori & Mendes 13270*. B, D–E. Photos by C. Carollo Matos based on *Prance & Silva 24237*. F–G. Photos by C. Gracie based on *Mori et al. 20629*. H–K. Photos by C. Carollo Matos based on *M. Freitas 598* (specimen at INPA).

***Bertholletia excelsa* Bonpl. clade** (Fig. 9)

Ovary 4-locular. Septal units as seen in cross-section through placentae: arrowhead-shaped, the basal extensions short and thin (B). Locule orientation and width as seen in longitudinal section: vertical, widest at middle (E) or width intermediate (D). Lower septum: truncate at apex, occupying ca. 50–60% of lower/upper septum length (D, E). Placentae as seen in longitudinal section: plateau columnar (E). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, ca. 7 per locule, in ca. 2 columns (B) and 2 rows (E), inserted at apex of lower septum, with distinct ovule-free area below ovule insertion (D, E).

***Cariniana* clade** (Fig. 10)

Ovary 3(4)-locular. Septal units as seen in cross-section through placentae: spear-shaped (G–H). Locule orientation and width as seen in longitudinal section: vertical (D, I), widest at middle (I). Lower septum truncate at apex (D, I), occupying ca. 60% of lower/upper septum length (I). Placentae as seen in longitudinal section: narrow columnar (I). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, ca. 8 per locule, in 2 columns (C, H) and 5 rows (E, J), inserted along most of lower septum, with very short ovule-free area below ovule insertion (E, I, J).

***Corythophora* clade** (Fig. 11)

Ovary (2)3(4)-locular. Septal units as seen in cross-section through placentae: anchor-shaped, the head rounded, the basal extensions thick (C, H). Locule orientation and width as seen in longitudinal section: oblique (D), widest at middle (I). Lower septum: invaginate at apex, (I), occupying ca. 30–40% of lower/upper septum length (D, I). Placentae as seen in longitudinal section: spreading (D, I). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, ca. 3–24 per locule, in 26 columns (C–G), and 2–4 rows (D, I–J), without apparent ovule-free area at base of lower septum (D, I).

***Couratari* clade** (Fig. 12)

Ovary 3–locular. Septal units as seen in cross-section through placentae: arrowhead-shaped, the basal extensions thick (B, E, H). Locule orientation and width as seen in longitudinal section: oblique (C–F), widest at apex (C, F, J). Lower septum: invaginate at apex (F, J), occupying ca. 50–70% of lower/upper septum length (C, F, I–J). Placentae as seen in longitudinal section: arched columnar (C, F, I–J). Ovules as seen in cross- and longitudinal sections: not pendulous, distinctly flattened, ca. 10–50 per locule, in 4–8 columns (B, E, H) and 4–9 rows (C, F, I–J), without apparent ovule-free area at base of lower septum (C, F, I–J).

***Couroupita* clade** (Fig. 13)

Ovary 6-locular. Septal units as seen in cross-section through placentae: arrowhead-shaped, the basal extensions long and thin (D, H). Locule orientation and width as seen in longitudinal section: vertical (C, E, I), width intermediate (E, I). Lower septum: armed at apex (E), occupying ca. 90% of upper/lower septum length (E, I). Placentae as seen in cross- and longitudinal sections: laminar cup-shaped (E, I). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, ca. 40–90 per locule, in 4–6 columns (C, G) and ca. 10–25 rows (C, G, I), inserted along most of lower septum, with short ovule-free area below ovule insertion (E, G, I).

Eschweilera integrifolia clade (Figs. 14–16)

Ovary 2(3)-locular. Septal units as seen in cross-section through placenta: anvil-shaped, the head truncate, the basal extensions thick (14C–E, 15B, 16C). Locule orientation and width as seen in longitudinal section: oblique (Fig. 14F–G, 15C, 16D–E), width intermediate (Fig. 14G), widest at apex (Fig. 15C), or at middle (Fig. 16I). Lower septum: invaginate (Figs 14G, 15C, 16D–E) to nearly truncate at apex (Fig. 16I), occupying 25–60% (Fig. 16J) of lower/upper septum length. Placenta as seen in cross- and longitudinal sections: spreading (Figs. 14G, 15C, 16E) or plateau columnar (Figs.

16J). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, ca. 5–12 per locule, in 5–10 columns (14B–C, 15B, 16B) and 1 row (Figs. 14F–G, 15C, 16D–E), without apparent ovule-free area at base of lower septum (Figs 14F, 15C, 16D–F) or infrequently with distinct ovule-free area below ovule insertion (e.g., *E. collinsii*, Figs. 16I–J).

***Eschweilera parvifolia* Mart. ex DC. clade** (Fig. 17)

Ovary 2-locular. Septal units as seen in cross-section through placenta: anvil-shaped, the head truncate, basal extensions scarcely developed (16B). Locule orientation as seen in longitudinal section: oblique (D–E, I–J), width intermediate (I–J) or widest at apex (D). Lower septum: invaginate (D, I), occupying ca. 10–30% of lower/upper septum length (E, I–J). Placenta as seen in longitudinal section: spreading (D, I–J). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, 4–11 per locule, in 4–10 columns (B, G) and 1 row (B–C), without apparent ovule-free area at base of lower septum (Figs. E, I—J).

***Eschweilera tetrapetala* S.A. Mori clade** (Fig. 18)

Ovary 2-locular. Septal units as seen in cross-section through placentae: anvil-shaped, the head truncate, the basal extensions not well-developed (C, difficult to see). Locule orientation and width as seen in longitudinal section: oblique (E, J), width widest at apex (E, I—J). Lower septum: truncate at apex, occupying ca. 20–30% of lower/upper septum length (E). Placentae as seen in longitudinal section: spreading? Ovules as seen in both cross- and longitudinal sections: not pendulous, not flattened, ca. 6–15 per locule, in 2–6 columns (B–H) and 2–3 rows (B, H—I), without apparent ovule-free area at base of lower septum (E, I—J).

***Grias* clade** (Fig. 19)

Ovary (3)4-locular. Septal units as seen in cross-section through placentae: spear-shaped (B, F). Locule orientation and width as seen in longitudinal sections: vertical (C–D, G–H), width intermediate (D—G). Lower septum: armed at apex (H), occupying nearly 100% of upper/lower septum length not including lower septum arms (D, G—H). Placentae as seen in longitudinal section: incipient (D, G—H). Ovules as seen in cross- and longitudinal sections: pendulous (C—D, G—H), not flattened, 2–3 per locule, in 2 columns (B) and 1–2 rows (B, G—H), inserted at apex of lower septum, with long ovule-free area below ovule insertion (D, G—H).

***Gustavia* clade** (Fig. 20)

Ovary 4–8 locular. Septal units as seen in cross-sections through placentae: spear-shaped (G) or arrowhead-shaped (B, only in *Gustavia* sect. *Hexapetala*), the basal extensions short. Locule orientation and width as seen in longitudinal section: vertical (J) or oblique (D–E), width intermediate (D, J). Lower septum: armed at apex (no image), occupying most of upper/lower septum length (C–D, I–J). Placentae as seen in longitudinal section: cup-shaped (I) or laminar cup-shaped (D—E). Ovules as seen in cross- and longitudinal sections: not pendulous, ca. 25–50 per locule, in 4 columns (B—C) and ca. 6–8 (in *Gustavia* sect. *Hexapetala*) and ca. 20 rows (I—J), inserted from near middle or less to apex of lower septum, with distinct ovule-free area below ovule insertion (D, I—J).

***Lecythis chartacea* O. Berg clade** (Fig. 21)

Ovary (3)4(5)-locular. Septal units as seen in cross-sections through placentae: arrowhead-shaped, the basal extensions thick (E). Locule orientation and width as seen in longitudinal section: vertical (C, F) or oblique (J—K), widest at middle (C, F, J—K). Lower septum: truncate (F) or invaginate (C, K), occupying ca. 50–60% (C, J—K) of upper/lower septum length. Placentae as seen in longitudinal section: spreading (C, J—K), or plateau columnar (F, only in *L. brancoensis* (R. Knuth) S.A. Mori). Ovules as seen in cross- and longitudinal sections: not pendulous, not flattened, ca. 4–28 per locule, in 2–4 columns (H—I) and 4–7 rows (C, F, I, J—K), without apparent ovule-free

area at base of lower septum (C, J–K) or infrequently with short ovule-free area below ovule insertion (F, e.g., *L. brancoensis*).

***Lecythis corrugata* Poit. clade** (Fig. 22)

Ovary 4(5)-locular. Septal units as seen in cross-sections: arrowhead-shaped, the basal extensions thick (E). Locule orientation as seen in longitudinal section: horizontal (I) or oblique (C, F), widest at apex (C, F) or at middle (I). Lower septum: invaginate at apex (C, F, I), occupying 10–50% (C, F, I) of upper/lower septum length. Placentae as seen in longitudinal section: spreading (C, F, I). Ovules as seen in cross and longitudinal sections: not pendulous, not flattened, ca. 4–8 per locule, in 2–4 columns (B, H) and 1–2 rows (C, F, I), without apparent ovule-free area at base of lower septum (C, F, I).

***Lecythis ollaria* L. clade** (Fig. 23)

Ovary (3)4(5)-locular. Septal units as seen in cross-sections through placentae: arrowhead-shaped, the basal extensions thick (B). Locule orientation and width as seen in longitudinal section: horizontal (C) or oblique (D, G, J), widest at apex (C, D, G) or at middle (J). Lower septum: invaginate at apex (D, G), occupying ca. 30–40% of lower/upper septum length (C–D, G). Placentae as seen in longitudinal section: spreading (C–D, G, J). Ovules as seen in cross and longitudinal sections: not pendulous, not flattened, ca. 3–11 per locule, in 3–4 columns (B, F, I) and 2–4 rows (B–D), without apparent ovule-free area at base of lower septum (C–D, G).

***Lecythis pisonis* clade** (Fig. 24)

Ovary 4-locular. Septal units as seen in cross-sections: arrowhead-shaped, the basal extensions thick (B, F). Locule orientation and width as seen in longitudinal section: oblique (D) or vertical (H), widest at middle (C, D, H). Lower septum: truncate at apex (D, H), occupying ca. 40–80% of upper/lower septum length (C–D, H). Placentae as seen in longitudinal section: Laminar cup-shaped (C, H). Ovules as seen in cross and longitudinal sections: not pendulous, not flattened, ca. 8–24 per locule, in ca. 3 columns (F, I) and 3–4 rows (C, H–I), inserted along most of lower septum, with short ovule-free area above and below ovule insertion (D, H–I).

***Lecythis poiteaui* O. Berg clade** (Fig. 25)

Ovary (3)4(6)-locular. Septal units as seen in cross-sections through placenta: arrowhead-shaped, the basal extensions short, thick (C, I). Locule orientation and width as seen in longitudinal section: vertical (J) or oblique (D), widest at middle (D) or width intermediate (J). Lower septum: truncate at apex, occupying ca. 50% of lower/upper septum length (D, J). Placentae as seen in longitudinal section: arched spreading (D, J). Ovules as seen in cross and longitudinal sections: not pendulous, not flattened, ca. 6–20 per locule, in 2–4 columns (B–C, I) and 3–5 rows (D, J–K), inserted from apex of lower septum to near base, with very short ovule-free area below ovule insertion.

THE OVARY

The placentae of New World Lecythidaceae appear axile as seen in a cross-sections through the area of the placenta to which the ovules are attached although the carpels are sometimes not entirely fused (Fig. 2). A cross-section at this level also shows the number of locules in an ovary, the relationship of the placentae to the septa, and the manner in which the ovules arise from the placenta. If a section is made above the ovule attachment, the septa may not be fused at their apices and, as a result, the placentation appears parietal or intruded parietal. This has been pointed out by Schoenberg (1983a) and Monteiro-Scanavacca (1975) for *Couroupita guianensis*. Because this decision is arbitrary, we conclude that the placentation of this family should continue to be classified as axile. We also base this conclusion on the fact that where the ovules are attached the apices of the septa are usually fused together or are in very close approximation as seen in cross-sections. The evolution of

placentation in New World Lecythidaceae has not been adequately addressed and, thus, it is not known if the ovary is derived from an ancestor with parietal placentation and the apical placentae have not fused or if the ancestor had axile placentae in which the septa in the upper part of the ovary separated to form what looks like parietal placentation toward the apex of the ovary. It is not unusual among flowering plants to have placentation that appears axile toward the base and parietal toward the apex, which is often interpreted as a stage in the evolution of axile from parietal placentation. In addition, it has been observed that species with axile placentation at anthesis often show parietal placentation in early bud development stages (Gunderson 1939) and that fusion of the carpels develops from the base to the apex of the ovary (Endress 1994).

The septa (the walls that divide the ovary into different chambers [locules]) are generally considered to have evolved from proto-angiosperms in the early evolution of angiosperms. The origin of the ovary of angiosperms and whether it has evolved once or more than once is still under debate. Whatever their origin, the structures that form the ovary are called carpels and their number is usually revealed by counting the number of locules, the number of stigmatic lines or lobes, or the number of valves making up the outer walls of the ovary. In Lecythidaceae, the number of carpels forming an ovary based on the number of valves does not work because the valves are surrounded by a hypanthium, thus the sutures of the ovary walls are not apparent. In New World Lecythidaceae, the style is only divided in some species of *Grias* and the number of stigmatic lines is only apparent in species of *Gustavia* and *Couroupita*. Both Monteiro-Scanavacca (1974) and Schoenberg (1983a) concluded that the hypanthium is appendicular, i.e., it originated from fused sepal, petal, and stamen tissue. According to Schoenberg (1983a), the hypanthium does not participate in the development of the fruit.

A medial longitudinal section of the ovary shows that the septae are divided into a lower and upper septum separated by a septal articulation (Fig. 2G, K). The placentae always arise from the lower septum We hypothesize that there are no known selective advantages for ovaries that produce indehiscent fruits to develop an upper septum and therefore suggest that it is usually vestigial in species with fruits that do not dehisce (e.g., species of *Gustavia*, *Grias*, and *Couroupita*). Species of this group usually fall to the ground and are generally dispersed by animals. In most dehiscent-fruited species the upper septum develops into a woody projection that protrudes from the inside of the operculum and is called the columella. The most developed columellae are associated with cylindrical fruits (*Allantoma*, *Cariniana*, and *Couratari*) that possess winged seeds and are usually dispersed by the wind. Less markedly developed columellae are found in the dehiscent fruited *Lecythis pisonis* clade that is dispersed by bats seeking the well-developed aril as a reward. The remaining clades lack a columella but sometimes the septal walls tightly surround the basal part of the seed and the operculum and the seeds fall to the ground together (e.g., in relatively few species of the *Eschweilera parvifolia* clade).

We use *Couroupita* (Figs. 2A–F, Fig. 4) to illustrate the terms employed for describing the placentation of New World Lecythidaceae because its placentae possess most of the characters found or modified from this genus. The three species of *Couroupita* have 6-locular ovaries, and unlike species of other genera, the locules seldom vary in number. The septa of the ovary are made up of what we hypothesize to be tissue derived from two adjacent carpels. We call the non-expanded part of the septum the septal stalk, the enlarged apex the septal unit head, and extensions from the base of the septal unit head, the septal unit extensions (Fig. 2E, Fig. 4). Septal unit heads differ in shape to a greater or lesser extent among genera as seen in cross-sections — in *Couroupita* the septal unit head is arrowhead-shaped. In this genus the septal unit consists of the non-differentiated septal stalk, the septal unit head, and relatively long septal unit extensions. In contrast, an individual locule is formed by a single carpel that forms the inner wall of a locule; thus there are six curved inward walls and six carpels in species of *Couroupita*. The placental tissue that bears the ovules is formed at the apical

ends of each carpel, and each is called a placental unit; thus there are two placental units within a locule derived from a single carpel (Figs. 14D, H) and together they make up what we call the placenta.

Nevertheless, there are three choices for what could be considered the placenta in *Couroupita* and other New World Lecythidaceae: (1) all of the tissue in a ovary to which ovules are attached, i.e., the combined placental tissue of all six locules; (2) all of the tissue associated with a single septal unit head, i.e., the combined tissue from two adjacent carpels (Figs. 2D); or (3) all of the tissue to which ovules are attached within a given locule, i.e., the combined placental tissue of a single carpel which in turn represents two placental units (Fig. 2B). We have elected to consider the latter as the placenta in Lecythidaceae because this definition is based on placental tissue derived from a single carpel.

USE OF PLACENTATION IN SEPARATING CLADES

In this section we discuss what placentation characters contribute to confirming or rejecting genera as circumscribed in the last monographs of New World Lecythidaceae (Mori & Prance 1990; Prance & Mori 1979). The clades presented are those recognized by Huang et al. (in press) and Mori et al. (in press), which are presented in alphabetical order in the following discussion.

***Allantoma* clade** (Fig. 7)

This clade includes the eight species of *Allantoma* (Huang et al. 2008; Mori et al., in press) for which an infrageneric classification has not been proposed. The description presented here is based only on *A. lineata* (Mart. ex Miers) O. Berg, which is the largest-flowered species of the genus. Once smaller-flowered species are studied, parts of the description in the **RESULTS** will change because the flowers of other species are very small (e.g., *Allantoma decandra* (Ducke) S.A. Mori, Y.-Y. Huang & Prance. This clade is characterized by the following combination of placentation characters: spear-shaped septal units; vertical locule orientation; upper septum truncate; narrow columnar placentae; and ovules arranged in 5–10 rows and two columns. These placental features are similar to those of the *Cariniana* clade. The clade is supported by morphology (Huang et al. 2008; Mori et al., in press) but the *Allantoma* clade is not resolved forming a polytomy with the *Cariniana* and *Couratari* clades (Fig. 1). Nevertheless, we hypothesize that *Allantoma* merits continued recognition as a distinct genus because of morphological differences in the leaves and flowers (Mori et al., in press).

The species of *Allantoma*, as circumscribed by Huang et al. (2008), are found mostly in western and central Amazonia but *Allantoma lineata* grows along the Rio Orinoco, Rio Negro, and the Amazon from its junction with the Rio Negro to the mouth of the Amazon (map not available). Species of *Allantoma* are absent from the Guianas, eastern Amazonia (except for *A. lineata*), and the forests of eastern Brazil.

Barringtonia clade (Fig. 8)

This clade includes 69 species (Prance 2012). The clade is characterized by the following combination of placentation characters: ovary 4-locular; ovules few and pendulous; and very long lower septum in comparison with the upper septum. These features are also found in species of *Grias* in the New World and we hypothesize the ancestor of these two genera to be the connection between the Old World and New World Lecythidaceae.

Additional study of the placentation of the genera of Old World Lecythidaceae is needed to determine if placentation features can contribute to an understanding of intergeneric relationships as well as to the relationships between Old and New World Lecythidaceae.

The species of *Barringtonia* are found in eastern Africa (including Madacascar), Southeast Asia, and Australia.

***Bertholletia excelsa* clade** (Fig. 9)

This species belongs to a monotypic clade that should not be confused with the more widely defined *Bertholletia* clade; the latter includes all of the zygomorphic-flowered clades except *Cariniana*, *Couratari*, and *Couroupita* clades (Huang et al., in press; Mori et al., in press). The following combined placentation features support the recognition of the *Bertholletia excelsa* clade: 4-locular ovaries; septal units arrowhead-shaped, the basal extensions short and thin; plateau columnar placentae; ovules in two rows; the lower septum truncate at apex; and an ovule-free area below the ovule attachments. Morphological (Huang et. al, in review) data support the recognition of the *Bertholletia excelsa* clade as a monotypic genus, but molecular data does not support or negate this conclusion because the genus is monotypic (Huang 2010). This type of placentation is also found in *Lecythis brancoensis* (R. Knuth) S.A. Mori that, based on molecular and morphological (Fig. 1) evidence, is placed in the *Lecythis chartacea* clade.

Bertholletia excelsa occupies most of the Amazon Basin (see Fig. 21 in Mori & Prance 1990) but this is probably because Amerindians planted the edible seeds everywhere they travelled, an idea supported by the discovery that there is little genetic variation among individuals throughout its range (Reis et al. 2009). Shepard and Ramirez (2011), linguistic data, suggest that the Brazil nut originated in the north-central Brazilian Amazon.

***Cariniana* clade** (Fig. 10)

This clade includes the nine species of *Cariniana* recognized by Huang et al. (2008) for which an infrageneric classification has not been proposed (Prance & Mori 1979). Huang et al. (2008) placed a number of species formerly part of *Cariniana* as defined by Prance in Prance and Mori (1979) in *Allantoma*. This clade is characterized by the following combination of placentation characters: 3-locular ovaries; spear-shaped septal unit heads; vertical locule orientation; narrow columnar placentae; ovules arranged in two columns and ca. 5 rows; and ovules alternately arranged as seen in longitudinal section when the locule wall is removed. These placental features are similar to those of the *Allantoma* clade. The clade is supported by morphological (Huang et al. 2008; Mori et al., in press) and weak molecular data (58% bootstrap support in Mori et al. 2007). Nevertheless, we conclude that it merits continued recognition as a genus separate from *Allantoma* and other New World Lecythidaceae because of morphological differences in the leaves, flowers, and fruits (Huang et al 2008), even though its relationships with that of other clades is not resolved.

The species of the *Cariniana* clade are found in the forests of the *Cerrado* of eastern Brazil into southeastern Bolivia and throughout western and southern Amazonia. *Cariniana pyriformis* Miers is the only species found both east and west of the Andes around Lake Maracaibo of Venezuela and northwestern Colombia (see Fig. 67 in Prance & Mori 1979). The genus is not represented in eastern Venezuela, the Guianas, and extreme eastern Amazonia (map not available) and has only recently been collected in Central America in eastern Panama.

***Corythophora* clade** (Fig. 11)

This clade includes the four species of *Corythophora* as circumscribed by Mori and Prance (1990). This genus has not been divided into subgenera which includes two clades — one with *C. amapaensis* Pires ex S.A. Mori & Prance and *C. labriculata* (Eyma) S.A. Mori & Prance (many ovules) and the other with *C. alta* R. Knuth and *C. rimosa* W.A. Rodrigues (few ovules), the latter with two subspecies (Huang et al. 2008, 2011). The anchor-shaped septal units are unique to this clade which is also supported by (Huang et al., in press) and molecular data (100% bootstrap support, Huang 2010); thus this clade merits continued recognition as a separate genus.

This clade is distributed in the Guianas and from central to eastern Amazonia. All collections come from north of the Amazon River (see Fig. 23 in Mori & Prance 1990).

***Couratari* clade** (Fig. 12)

This clade includes the 19 species of *Couratari* (Huang 2010; Huang et al. 2011; Mori et al., in press). The following combined placentation features support the recognition of the *Couratari* clade: 3-locular ovaries; septal units arrowhead-shaped; the basal extensions thick truncate at ends; and flattened ovules. This clade is also supported by morphological (Huang et al. 2011, in press) and molecular data (86% bootstrap support, Huang 2008) and merits continued recognition as a separate genus.

Prance in Mori & Prance (1990) recognized three sections in *Couratari*. Morphological (Huang et al. 2011, in press) and molecular data (Mori et al. 2007) support the recognition of *Couratari* sect. *Echinata*. The differences between *Couratari* sect. *Guianensis* and *Couratari* sect. *Microcarpa* may not be sufficient to merit their recognition.

The species of *Couratari* are found throughout the Amazonian Basin, the Guianas into Venezuela, in Central America from Panama to Costa Rica, and in the forests and savannas of eastern Brazil (see Fig. 24 in Mori & Prance 1990).

***Couroupita* clade** (Fig. 13)

This clade includes the three species of *Couroupita* (Mori et al., in press) for which an infrageneric classification has not been proposed. The clade is characterized by the following combination of placentation characters: 6-locular ovaries; ca. 40–90 ovules per locule; arrowhead-shaped septal units with long, thin basal extensions, lower septum armed, and an ovule-free area below the ovules. The clade is also supported by morphological (Mori et al., in press) and molecular data (100% bootstrap support, Mori et al. 2007) and merits continued recognition as a genus.

Couroupita nicaraguarensis DC. is distributed west of the Andes from northwestern Ecuador to Nicaragua, *C. guianensis* encircles the Amazon in what has been called a periamazonian distribution by Jean-Jacques de Granville (1992), and *C. subsessilis* Pilg. is found along the Amazon River and some of its major tributaries (see Fig. 23 in Mori & Prance 1990).

***Eschweilera integrifolia* (Ruiz & Pav. ex Miers) R. Knuth** (Figs. 14–17)

The approximately 15 species of this group were first recognized as a clade by Huang (2010) based on morphological and molecular data. This clade had previously been placed in the more broadly defined *Eschweilera* sect. *Eschweilera* by Mori and Prance (1990). The *E. integrifolia* (Ruiz & Pav. ex Miers) R. Knuth clade can be recognized by the combination of the following placentation features: 2-locular ovaries, anvil-shaped septal units; lower septum invaginate; spreading placentae; and a single row of ovules. These features are also shared with the *E. parvifolia* clade. There is strong morphological (Huang et al., in press) and moderate molecular data (76% bootstrap support, Huang et al. 2010) supporting the recognition of this clade at some taxonomic level.

Eschweilera collinsii Pittier differs from other members of the *E. integrifolia* clade by having a narrow columnar placenta, truncate at the apex of the lower septum, and a single row of ovules that are not inserted in a single plane, i.e., they are placed at different levels along the placenta to form an upward oriented arch of ovules. This is the only species (with the exception of the *Bertholletia excelsa* clade, Fig. 10E) that we have studied in the broadly defined *Eschweilera* that has a columnar placenta and several rows of ovules (Fig. 17J).

Species of this clade are distributed in Central America as far north as the Osa Peninsula, in the Andean valleys and slopes of northwestern South America, and in western Amazonia.

***Eschweilera parvifolia* DC. ex Miers clade** (Fig. 17).

The approximately 70 species of this clade belong to *Eschweilera* sect. *Eschweilera* as recognized by Mori and Prance (1990). *Eschweilera parvifolia*, the type of the genus, belongs in this clade. This clade can be recognized by the combination of the following placentation features: 2-locular ovaries, anvil-shaped septal units; spreading placentae; and a single row of ovules. These features are shared with most of the species of the *Eschweilera integrifolia* clade but that relationship was not recognized by Mori and Prance (1990). There are strong morphological (Huang et al., in press) and weak molecular data (Huang et al. 2010) supporting the recognition of this clade, which excludes the *E. integrifolia* and *E. tetrapetala* clades (which were included as part of *Eschweilera* by Mori and Prance 1990).

The approximately 70 known species of this clade are distributed throughout northern South America and Central America, reaching Mexico in the north, and the area around Rio de Janeiro in the south (see Fig. 18 in Huang 2010).

***Eschweilera tetrapetala* clade** (Fig. 18)

The five species of this clade were placed in *Eschweilera* Sect. *Tetrapetala* by Mori and Prance (1990). The clade is recognized by the combination of the following placentation features: 2-locular ovaries, anvil-shaped septal units; invaginate lower septum; spreading placentae; and more than one row of ovules. The presence of anvil-shaped septal units is found only in this and the *E. integrifolia* and *E. parvifolia* clades but these clades have multiple rows of ovules per locule (Fig. 15) instead of a single row of ovules found in the latter clades (Figs. 14–17). Morphological (Huang et al. 2011, in press) and molecular data (99% bootstrap support in Huang 2010) support the recognition of this clade as separate from the other clades of *Eschweilera* but it is not resolved with other members or the larger *Bertholletia* clade.

The species of this clade are restricted to the coastal forests and adjacent savanna (*cerrado*) vegetation of eastern Brazil (see Fig. 16 in Huang 2010).

***Grias* clade** (Fig. 19)

This clade includes all 11 species of the genus (Cornejo & Mori 2012) for which an infrageneric classification has not been proposed (Prance & Mori 1979). This clade is characterized by the following combination of placentation characters: upper septum reduced, lower septum long and armed; incipient placentae; pendulous ovules; and a long ovule-free area below the ovules. The clade is supported by morphological (Cornejo & Mori 2010) and molecular (99% bootstrap support, Huang 2010) data and merits continued recognition as a genus.

Species of the *Grias* clade are the only New World Lecythidaceae with very few pendulous ovules located at the summit of the ovary which are also found in *Barringtonia* and some of its relatives in the Old World subfamily Barringtonioideae. Numerous drawings of the pendulous ovaries of *Barringtonia* are illustrated in Payens (1967).

The species of *Grias* are mostly found in the Andean valleys and slopes of northwestern South America, but two occur in western Amazonia, and another ranges from Central America into northwestern South America (a disjunct distribution of it occurs in Jamaica) (see Fig. 20 in Mori & Prance 1990).

***Gustavia* clade** (Fig. 20)

This clade includes the 43 species of *Gustavia* as defined by Mori and Cornejo (2013). The clade is characterized by the following combination of placentation characters: upper septum reduced or absent; cup-shaped or laminar cup-shaped placentae; lower septum armed or not armed at apex; and well-defined ovule-free area below the insertion of ovules. Morphological (Mori & Cornejo 2013) and molecular data (100% bootstrap support, Mori et al. 2007) also support its continued recognition as a separate genus. However, Prance and Mori (1979) recognized the following sections of the genus: *G.* sect. *Hexapetala*, *G.* sect. *Grandibracteata*, and *G.* sect. *Gustavia*. The first section is supported by molecular data (Mori et al. (2007, Jackknife support of 100%) but most morphological data does not support its segregation from the rest of the genus. Placental features (septal heads arrowhead-shaped (instead of spear-shaped); lack of lower septal arms (instead of septal arms present); and laminar cup-shaped placentae (instead of cup-shaped) differ from other species of the genus. There is no support for separating the other two sections of the genus because only one species of the *G.* sect. *Grandibracteata* was used in the molecular based study (Mori et al. 2007).

Species of *Gustavia* are found throughout Amazonia into Central America as far north as western Panama, the greatest diversity is associated with the Andes of northwestern South America and the mountains and lowlands of Panama. The widespread *G. augusta* L. is the only species that reaches the coastal forest of eastern Brazil and then it is restricted to the northern part of that phytogeographic area (see Fig. 26 in Mori & Prance 1990).

***Lecythis chartacea* clade** (Fig. 21)

The approximately nine species belonging to this clade were assigned to *Lecythis* sect. *Lecythis* by Mori & Prance (1990) which also includes the following clades recovered by Huang et al. (2010, in press): *L. ollaria*, *L. pisonis*, and *L. poiteaui*. There are no combined placentation features, only weak morphological differences, and weak molecular (73% bootstrap support, Huang 2010) data defining this clade; thus, there is insufficient support for recognizing the clade as a separate genus. Additional species, morphological characters, and genes should be included in a phylogenetic analysis to determine the placement and validity of this clade.

Although *L. brancoensis* (R. Knuth) S.A. Mori falls into the *L. chartacea* clade, the following placentation features do not support this placement: vertical locule orientation; plateau columnar placenta, an ovule-free area below ovule insertion, and the lower septum occupying ca. 80% of the lower/upper septum length. These are features shared by *Bertholletia excelsa*.

The species of this clade are mostly distributed in eastern Amazonian Brazil and the Guianas into Venezuela. There are, however, a few collections that have been gathered in western Amazonia (see Fig. 12 in Huang et al. 2010).

***Lecythis corrugata* clade** (Fig. 22)

The five species of this clade were placed in *Lecythis* sect. *Lecythis* by Mori in Mori and Prance (1990). This clade is characterized by the following combination of placentation characters: arrowhead-shaped septal head units; thick basal septal head extensions; lower septum invaginate; and spreading placentae. It is also supported by morphological (Huang et al., in press) and molecular data (99% bootstrap support, Huang 2010).

This clade is distributed in the Guianas and northeastern Amazonia in the states of Amapá, eastern Pará, and *Lecythis corrugata* is disjunct in the state of Amazonas around Manaus and in the Maracaibo basin in Venezuela (see Fig. 17 in Huang 2010). These species are only found south of the Amazon River in eastern Pará.

***Lecythis ollaria* clade** (Fig. 23)

The three species belonging to this clade (Huang 2010; Huang et al. 2011, in review) were placed by Mori in Mori and Prance (1990) in *Lecythis* sect. *Lecythis*. This clade is weakly characterized by the following combination of placentation characters: arrowhead-shaped septal units; thick basal extensions; and lower septum invaginate. In addition, this clade possesses an apomorphic morphological character (single-coiled androecial hoods with vestigial stamens only on the exterior of the coil [Huang et al., in press]) and molecular support for the clade [100% bootstrap support, Huang 2010]).

If *Lecythis*, as defined by Mori and Prance (1990), were redefined to include only the *Lecythis ollaria* clade the genus would be reduced to three instead of 26 species. This decision, however, should be deferred until additional species, morphological characters, and genes are included in a phylogeny analysis.

The species of the clade are found only in eastern Panama, northern Colombia, and north-central Venezuela (see Fig. 10 in Huang 2010 as the *Lecythis s.s.* clade).

***Lecythis pisonis* Clade** (Fig. 24)

The five species belonging to this clade (Huang 2010; Huang et al. 2011, in press) were recognized by Mori in Mori & Prance (1990) as *Lecythis* Sect. *Pisonis*. The following combined placentation features support the recognition of the *Lecythis pisonis* clade: 4-locular ovaries; septal units arrowhead-shaped; the septal head basal extensions thick; and laminar cup-shaped placentae. This clade is also supported by morphological (Huang et al., in press) and molecular data (100% bootstrap support, Huang 2010), which suggests that, with further study, the clade could be recognized as a separate genus.

The species of this clade are found in lowland forests of the Atlantic coastal forest of eastern Brazil, the Brazilian and Peruvian Amazon, the Guianas and adjacent Venezuela, and the Andean valleys of northwest Colombia into Central America as far north as Nicaragua (see Fig. 9 in Huang 2010 as the *Pachylecythis* clade).

***Lecythis poiteaui* clade** (Fig. 25)

The following species are known or hypothesized to belong to this clade: *L. barnebyi* S.A. Mori, *L. ibiriba* (Miers) N.P. Smith et al., *L. lurida* (Miers) S.A. Mori, *L. prancei* S.A. Mori, *L.* poiteaui, and *L. schwackei* (R. Knuth) S.A. Mori. There are no combined placentation features that separate this clade from other clades and molecular data is weak (73% bootstrap support, Huang 2010). Possible morphological features are dendritic and slightly impressed seed venation and absent or vestigial versus well-developed basal arils (Huang et. al., in review).

The species of this clade are found from central to eastern Amazonia and in the Atlantic coastal forest of eastern Brazil (see Fig. 13 in Huang 2010, as the *Holopyxidium* clade).

DISCUSSION

A significant obstacle to this study was the difficulty of obtaining buds of the same size for study. We do not know how much placentation characters as seen in sectioned buds change over the course of development; thus, if changes in form and position do take place comparing buds at one stage with buds at another stage may lead to false conclusions about placentation differences among clades. In addition, making sections consistently through the same place in different buds, even if they are at the same stage of development, makes it difficult to compare the sections; for example, a medial longitudinal section (Fig. 5) of a bud may differ in locule shape from another bud sectioned in longitudinal section in a slightly different place. However, the greatest problem in this study is the

small sample size used. Even though NYBG has more pickled flowers of Lecythidaceae than has ever been assembled, there are still not enough buds and flowers to determine how much variation takes place within an individual, among individuals of a population, and among individuals of different populations, a problem with almost all studies of plant systematics.

Because most collections of Lecythidaceae are dried under too much pressure and heat, our efforts to use buds and flowers from herbarium specimens often yielded sections too distorted and carbonized to show placentation features. On the other hand, buds that are dried in paper bags on low heat allow making acceptable sections after they have been boiled in water. Liquid preserved collections and fresh flowers sectioned in the field, however, give the best results.

In spite of the difficulty in making sections, placentation features of some genera of Lecythidaceae are so different that genera can be recognized based on placentation alone. In addition, placentation data adds information for future testing of the validity of genera as proposed in the latest monographs (Mori & Prance 1990; Prance & Mori 1979). For example, *Grias* (Cornejo & Mori 2010) encompasses the only New World species with a few pendulous ovules per locule and an incipient placenta (Fig.19) and this type of placentation is also found in species of Old World *Barringtonia* (Fig. 7). One can recognize species of *Grias* from species of *Barringtonia* based on geography and tricolpate vs. syntricolpate pollen but could conclude that there may be a relationship between species of *Grias* and *Barringtonia* because of their striking similarity in placentation and some morphological features. This hypothesis waits testing by preparing a more detailed species level phylogeny of both New World and Old World Lecythidaceae based on molecular data (Fig. 1). Note that species of *Gustavia* also have some floral features (e.g., a broad staminal tube with at least most of the stamens arising from the rim of a staminal tube) in common with some species of *Barringtonia* but the placentation of the two genera is different (compare Figs. 20 of *Gustavia* with Fig. 8 of *Barringtonia*) based on the few species we have examined or have been described and illustrated in the literature (Thomson 1921; Tsou 1994). The similarities of *Barringtonia* with *Grias* and *Gustavia* suggest links between the Old World tropics and New World tropics among these genera.

Most species of *Gustavia* can be recognized by their spear-shaped septal unit heads as seen in cross-section (Fig. 20G) and their cup-shaped placentae as seen in medial longitudinal section (Fig. 20I–J). However, *Gustavia* Sect. *Hexapetala* lacks these features — their septal unit heads are arrowhead-shaped (Fig. 20B). The placentae of this section (Fig. 20 D), however, are similar to species of *Couroupita* (Figs. 13D–E, H–I). Recognizing *Gustavia* sect. *Hexapetala* as a separate genus is not supported by floral morphology because sect. *Hexapetala* possesses actinomorphic flowers with a broad staminal tube and poricidal anthers, features not found in any other genus of Lecythidaceae but occurring in all other species of *Gustavia*. The similar placentation of *G.* sect. *Hexapetala* and the *Couroupita* clade suggest that the evolution of zygomorphy (excluding the obliquely zygomorphic *Cariniana* clade), which was first manifested in *Couroupita*, may have evolved from an actinomorphic-flowered ancestor similar to species of *G.* sect. *Hexapetala* clade. Supporting this idea is our field observations that some species of *Gustavia* are often very slightly zygomorphic even though they do not have a staminal ring extension as in other species of zygomorphic-flowered New World Lecythidaceae.

Recently some species of *Cariniana* were transferred to *Allantoma* based on several characters, the most significant being floral texture, symmetry, and texture (androecium membranous and zygomorphic and petals flat at apices in *Cariniana* and androecium fleshy and actinomorphic and petals hooked at apices in *Allantoma*). In addition, and leaves are different (tertiary veins usually reticulate in *Cariniana* and percurrent in *Allantoma*). The presence of unilaterally winged seeds (Mori et al., in press) is common to both genera. This is also supported by the nearly identical

placentae of *Allantoma* (Fig. 7) and *Cariniana* (Fig. 10). Those species with membranous, zygomorphic flowers remained in *Cariniana* and those with fleshy, actinomorphic flowers were transferred to *Allantoma* by Huang et al. (2008). Based on morphological data, *Cariniana* and *Allantoma* were recovered as sister clades (Huang et al. 2008) but when molecular data were added their relationship was not resolved.

The monotypic *Bertholletia excelsa* clade (Huang et al., in press) possesses morphological features (2-lobed calyces [Fig. 9F], a unique type of secondarily indehiscent fruit, and bony seed coats) that allow this species to be easily separated from other Lecythidaceae. However, these characters may not be good indicators of relationships. For example, the 2-lobed calyces are clearly evolved from ancestors with 6-lobed calyces (Tsou & Mori 2007) and secondary fruit indehiscence is found is several other species and seems to be a response to different dispersal agents, in this case rodents such as agoutis (Mori & Prance 1990). The bony seed coat, even though it is found only in *B. excelsa*, also appears to be an adaptation to seed dispersal by rodents. The plateau columnar placentation (Fig. 4B, Fig. 9E) also supports maintaining *Bertholletia* as a genus; however, *Lecythis brancoensis* of the *L. chartacea* clade, possesses a similar type of placenta (Fig. 21F) but with more rows of ovules than found in *B. excelsa*. With further studies, if *Bertholletia excelsa* (Bonpland 1808) were found to be embedded in a clade including only species currently placed in *Lecythis* the *Bertholletia* clade (Fig. 2) would have to be recognized as *Lecythis* because that genus was published before the publication of all other New World genera (Loefling 1758).

In addition to the unilaterally winged seeds of *Allantoma* and *Cariniana*, the only other genus with winged seeds is *Couratari* but the wings of species of this clade are circumferential versus unilateral and have a different origin (flattened aril in the former two genera and flattened seed in the latter genus) (Tsou & Mori 2007). The placentation of the *Allantoma* and *Cariniana* clades differ from the *Couratari* clade by the columnar placenta of the first two genera (Figs. 7C, 10D, I;) versus arched columnar placentae of *Couratari* (Fig. 12C, F, J), and spear-shaped (Figs. 7B–C) versus thick septal head extensions (Figs. 12B, E, H).

The *Corythophora* clade forms a monophyletic group supported by morphological (Huang et al., in press) and molecular data (Fig. 1). However, the morphological features need to be applied in combination using the following characters: squamose inflorescence rachises, non-coiled androecial hoods, the presence of both fertile and sterile (= fodder) pollen, and thick-walled campanulate or cylindric fruits. On the other hand, the anchor-shaped septal unit heads (Fig. 3E) are not found in any of the other clades of New World Lecythidaceae.

The three clades of *Eschweilera*, as circumscribed by Mori and Prance (1990), were recovered by Huang (2010). These are the *E. tetrapetala* (= *E.* sect. *Tetrapetala* in Mori & Prance, 1990), *E. integrifolia*, and *E. parvifolia* (includes the type *E. parvifolia*) clades. The *E. tetrapetala* clade is similar in placentation to the other two clades in its 2-locular ovaries and anvil-shaped septal head unit but the ovules are arranged in several rows (Fig. 18B–H) instead of in a single row as they are in the *E. integrifolia* (Fig. 14B–C, E) and *E. parvifolia* (Fig. B, G) clades (Huang et al., in press). With the insight provided by a better understanding of placentation, we discovered that the *E. tetrapetala* clade also differs in having a single-coiled instead of double-coiled (*E. parvifolia* clade), or triple-coiled (*E. integrifolia* clade) androecial hood (Huang et al., in press) and a short, basal aril instead of a lateral aril as found in the type of the genus and the *E. parvifolia* clade in general; thus, based on these differences we hypothesize that the *E. tetrapetala* clade represents generic status.

The presence of triple-coiled androecial hoods and spreading arils (a few species, e.g., *E. antioquensis* Dugand & Daniel and *E. jacquelynieae* S.A. Mori may have neither spreading or lateral arils) characterize the *E. integrifolia* clade while double-coiled androecial hoods and lateral arils separate the *E. parvifolia* clade. These two clades are the only ones with a single row of ovules (e.g.,

Figs. 14C, 15B, 16(B), 17(B). An exception is *Eschweilera collinsii*, which has triple-coiled androecial hoods and spreading arils and falls within the *E. integrifolia* clade based on these characters and molecular data (Huang, in review), but its placentation differs from the *E. integrifolia* *E. parvifolia* clades by having more than one row of ovules and by possessing a distinct space between the attachment of the ovules and the base of the lower/upper septum (Fig. 16K).

Within *Lecythis* as defined by Mori and Prance (1990), Huang et al. (in press) recovered the following clades: *L. chartacea*, *L. corrugata*, *L. ollaria*, *L. pisonis*, and *L. poiteaui* clades (Fig. 1). There is morphological (Huang et al., in press) and molecular (Huang, 2010) support for recognizing the *L. corrugata*, *L. ollaria*, and *L. pisonis* clades as separate genera but placentation characters do little to support or negate these hypotheses.

Based on the studies of Mori et al. (2007) and Huang et al. (in press) it has become apparent that the generic concepts of *Eschweilera* and *Lecythis* are not monophyletic as intimated by Mori and Prance (1990). The placentation data reported in this paper add support to this suggestion and are also useful in confirming the generic status of other genera in other genera of New World Lecythidaceae.

ACKNOWLEDGEMENTS

The senior author is grateful to the NSF-OPUS program for supporting this synthesis of the research he and his collaborators have contributed to the systematics and ecology of the Brazil nut family. In addition, this research has received support for mapping New World Lecythidaceae as part of a collaborative grant (*Dimensions US-Biota-São Paulo: Assembly and evolution of the Amazon biota and its environment: an integrated approach*) provided by the US National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP). We are grateful to Don Black for preparing the microscopic slides used in this study and the collectors who made the herbarium and liquid preserved collections from which buds and flowers for sectioning were obtained. We are especially grateful to G. Aymard, R. Aguilar, and X. Cornejo for the special efforts they made to collect material for this study.

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TABLE LEGENDS

Table I. Terms used to describe the placentation of New World Lecythidaceae. These terms are illustrated in Figures 3 to 7 and in the remaining figures used to illustrate the placentation of the currently recognized clades of Lecythidaceae.

TABLE I
TERMS USED TO DESCRIBE THE PLACENTATION OF NEW WORLD LECYTHIDACEAE

The terms are arranged in groups of characters and not alphabetically. Each group of terms is defined under the section heading.

SECTIONS

Sections are made either at right angles to the main axis of the ovary (Fig. 2A), parallel through the main axis of the ovary (Fig. 2G), or parallel but not through the main axis of the ovary (Fig. 2I). All of the data obtained for this study were made with one or the other or a combination of these three types of sections.

Cross (= transverse) **section**. A section made at right angles to the long axis of an ovary (Fig. 2A). This type of section facilitates determining the number of locules, number of ovules per locule, the number of columns of ovules on the placenta, the relationship of the septa to the placentae, and the attachment of the ovules to the placenta. The most complete information is obtained by making a section through the middle of the placenta.

Medial longitudinal section. A section through the middle and parallel to the long axis of an ovary such that the stylar canal is visible (Fig. 2G). This type of section facilitates determining the shape and orientation of the locules, numbers of ovules per locule, the attachment of the ovules to the placenta, the shape of the placentae, and the relationship of the lower to the upper septum (i.e., what percent the lower septum of the lower/upper septum occupies when viewed in this section).

Longitudinal section. A section along the long axis of an ovary but not through the middle of the ovary. This type is useful for removing the outer wall of the ovary to reveal the number of columns and rows of ovules (Figs. 2I).

SEPTUM (pl. = septa)

A wall-like partition that divides an ovary into chambers called locules (Fig. 2A, C). The septa are made up of the walls of adjacent carpels (Fig. 2D).

Lower septum. A wall-like partition of a locule located basally to an articulation best seen in medial longitudinal section of an ovary (Fig. 2G). The upper septum is sometimes not apparent.

Upper septum. A wall-like partition of a locule located apically to an articulation as seen in a medial longitudinal section of an ovary (Fig. 2G). The upper septum is sometimes not apparent.

Lower/upper septum. The combined lengths of the lower and the upper septa as seen best in medial longitudinal section of an ovary; the two septa are divided by a septal articulation (Fig. 2H). The lower septum gives rise to the placenta and the upper septum, when present, develops into the columella of the fruit.

Lower/upper septum articulation. A joint located between the lower septum and the upper septum as seen in a medial longitudinal section of an ovary. The articulation can be represented by a thin line or a narrow gap (Fig. 2H)

Apex of lower septum truncate. The apical end of the lower septum forms a horizontal line or gap as seen in a medial longitudinal section (Fig. 2K). This feature is not obvious in species that have armed lower septa, e.g., species of *Grias*, *Gustavia*, and *Couroupita*.

Apex of lower septum invaginate. The apical end of the lower septum forms a slight depression into which the upper septum is inserted as seen in medial longitudinal section (Fig. 2L).

Apex of lower septum armed. The apical end of the lower septum is separated into two prolongations (the dashed lines in Fig. 2J) upward as seen in medial longitudinal section. The arms of the lower septum surround the stylar canal.

Septal unit. The shape of a septum is revealed in crosssection (Fig. 1D– F). The septal unit consists of tissue from adjacent carpels and includes the septal unit stalk, the septal unit head, and sometimes basal extensions from the septal unit head. There are 4 septal units in a 4-locular ovary, 6 in a 6-locular ovary, etc.

Septal unit stalk. The part of the septum that departs from its departure from the wall of the ovary to the point at which it expands into the septal unit head (Fig. 2F). The septal unit stalk is derived from the walls of adjacent carpels and, with the septal unit head, makes up the septal unit. This character is observed in cross-section.

Septal unit head. The expanded part located at the apex the septal unit (Fig. 2F). One-half of the septal unit head is derived from one carpel and the other half is derived from the adjacent carpel. This character is seen in cross-sections.

Basal extensions. Referring to basal extensions from a septal unit head to which the ovules are attached (Fig. 2F). There are two basal extensions in a septal unit, each of which is derived from an adjacent carpel. This character is seen in cross-sections. Some species may not have basal extensions.

SEPTAL UNIT SHAPES

This section refers to shape of the septal unit head and their basal extensions (when present) as seen in cross-sections. In order to observe this character the section must be made through the middle of the placenta where the ovules are attached.

Septal unit anchor-shaped. A septal unit in which the sepal unit head expands at the apex to form a broad and rounded head that appears anchor-like as seen in cross-sections of an ovary (Fig. 3E–E^2).

Septal unit anvil-shaped. A septal unit in which the septal unit head is truncate at the apex as seen in cross-sections (Fig. 3F). This type is only found in species with 2-locular ovaries.

Septal unit arrowhead-shaped. A septal unit head that possesses basal extensions. (Fig. 3). Combined with the septal unit stalk the entire structure looks like an arrow.

Septal unit spear-shaped. A septal unit head that expands at the apex to form a triangle and tapers at the base to the septal unit stalk (Fig. 3A– A^3). Species that have equal sides, i.e., appearing like a diamond, are also classified as spear-shaped.

LOCULES

Locules are the chambers of an ovary (Fig. 2C). The number of locules is observed in a cross-section of the ovary while all other characters of locules are observed in a medial longitudinal section.

Locule number. The number of chambers as they appear in a cross-sections of an ovary (Figs. C, E). In order to reveal the correct number of locules the section should be made through the middle of the placenta. The locules are shaded in Fig. 3A.

Locule orientation (Fig. 4A–E). The orientation of a locule as it appears in relation to the main axis of the ovary. This feature is seen in a medial longitudinal section.

Locule orientation horizontal (Fig. 4C). A locule oriented horizontally to the central axis of the ovary at an angle of more than 60 degrees as seen in a medial longitudinal section. A perfectly horizontally oriented locule would have an angle of 90 degrees.

Locule orientation oblique (Figs. 4D). A locule oriented obliquely with the central axis of the ovary at an angle between 30 and 60 degrees as seen in a medial longitudinal section.

Locule orientation vertical (Figs. 4A–B). A locule oriented vertically to the main axis of the ovary or at an angle less than 30 degrees as seen in medial longitudinal section.

Locule width (Fig. 4F–I). The location of the greatest width of a locule measured between the outside and inside walls as seen in medial longitudinal section.

Locule width at apex (Fig. 4F) The greatest width of a locule occurs at the apex of the locule as seen in medial longitudinal section.

Locule width intermediate (Fig. 4I). The greatest width of a locule occurs between the middle and the apex of the locule as seen in medial longitudinal section.

Locule width at middle (Fig. 4G). The greatest width of a locule occurs at the middle of the locule as seen in medial longitudinal section.

Locule width at base (Fig. 4F). The greatest width of a locule occurs at the base of the locule as seen in medial longitudinal section.

PLACENTATION

In the broadest sense the tissue to which ovules are attached within an ovary. We consider New World Lecythidaceae to possess axile placentation limited to the tissue derived from a single carpel.

Placenta (pl. = placentae) (Fig. 5). Tissue derived from a single carpel to which the ovules are attached. Under our definition, the number of placentae in an ovary is the same as the number of locules.

Placental unit (Fig. 2B). One of two parts of a placenta located in the same locule and derived from the same carpel. Do not confuse this with septal unit.

Placenta incipient (Fig. 4A, 5D). A placenta barely expanded from the septum and with a very long ovule-free area from the base of the lower septum to the first ovules as seen in medial longitudinal section. This type of placentation is associated with apical, pendulous ovules.

Placenta laminar cup-shaped (Figs. 5A). A type of placenta in which the ovules are attached to long basal extensions of the septal unit heads as seen in cross-sections (arrow-head shaped, Fig. 3C) and with an ovule-free area from the base of the lower septum to the attachment of the first ovules as seen in medial longitudinal section. The placentae in two adjacent locules arch or curve from the base to form long septal unit bases.

Placenta cup-shaped (Fig. 5B, C). Same as the preceding except the septal unit basal extensions are absent making them spear-shaped in cross-sections (Fig. 3A). In medial longitudinal section the combined septa appear cup-shaped. This type of placenta is similar to laminar cup-shaped placentae but the basal extensions of the septal unit heads are absent (Fig. 3A–A[1]).

Placenta narrow columnar (Fig. 4G). A type of placenta that is narrow throughout the length of the lower septum and with a short ovule-free area on the lower septum from the base of the locule to attachment of the first ovules as seen in medial longitudinal section. In this type, the area where ovules are attached along the lower septum is relatively long (Figs. 6C).

Placenta plateau columnar (Fig. 5G). A type of placenta that has parallel sides and is truncate at apex of the lower septum. In this type, the area where the ovules are attached at the summit of the lower septum is relatively short (Figs. 9E).

Placenta spreading (Figs. 5F). A type of placenta derived from a horizontally expanded lower septum as seen in medial longitudinal section. The ovules all appear attached to the floor or near to the floor of the locule.

Placenta arched spreading (Fig. E). A type of placenta derived from a horizontal to slightly slightly horizontally septum as seen in medial longitudinal section. This type differs from spreading aril but has more ovules that appear to arch from the base of the lower septum to its apex (it curves from the base to the apex of the lower septum).

OVULES

An ovule is the organ that contains the egg and, after fertilization, develops into the seed. The ovules are included within locules of an ovary and may differ in their orientation along the lower septum. In Lecythidaceae the ovules always arise from the lower septum.

Ovule insertion (Fig. 6). This feature describes the orientation of the ovules in relation to the main axis of the ovary as seen in medial longitudinal section. Ovules may have different orientations along the same lower septum. They can be oriented vertically (2J), horizontally (Fig. 6D), obliquely outward and upward (Fig. 6C at the apex), obliquely outward and downward (Fig. 6C at the base).

Ovule columns. Vertically oriented lines of ovules as they appear in a locule of an ovary. This feature is seen in a longitudinal section that removes the outside wall of the ovary (Figs. 6B, F–H) or in a cross-sections (Fig. 6I). Because there are usually fewer columns at the base and apex of the count should be made in the middle of the placenta.

Ovule rows (Fig. 6B). Horizontally oriented lines of ovules as they appear in a locule of an ovary. A longitudinal section that removes the outside wall of a locule allows this feature to be seen with the most accuracy. It can also be observed in medial longitudinal sections.

Ovule orientation pendulous (Figs. 6E, 8I–J). Downward oriented ovules as seen in medial longitudinal sections of an ovary. Only *Barringtonia* and *Grias* have this type of ovule orientation.

Ovule orientation not pendulous. Ovules that are oriented in the following way: vertical, obliquely upward and outward, horizontally, and obliquely downward and outward oriented. These types of orientation are related to the type of placentation and the position on the placenta where the ovules are attached. All ovule orientation, except in species of *Barringtonia* and *Grias*, are is included in this category.

Jackson, C.D., A.M. Powell, and B.J. Warnock. 2015. Rediscovery of *Plateilema palmeri* (Asteraceae) in Brewster County, Texas. Phytoneuron 2015-14: 1–8. Published 3 March 2015. ISSN 2153 733X

REDISCOVERY OF *PLATEILEMA PALMERI* (ASTERACEAE) IN BREWSTER COUNTY, TEXAS

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ABSTRACT

Plateilema palmeri (A. Gray) Cockrell is a little understood and infrequently documented species of the composite family known from a few collections in Coahuila and Nuevo León, Mexico, and in the USA. This species has not been observed in the USA since 1929, when two specimens were collected by Henry T. Fletcher in west-central Brewster County, Texas. A population was rediscovered in 2014, growing within a long-term grassland restoration site approximately 70 km south of Alpine, Texas. Analysis of these plants revealed an identical chromosome number to a population in Mexico, $2n = 26$. Continuing field studies have documented a number of additional populations of *P. palmeri* throughout similar habitats in the desert grassland area known as the Green Valley on the O2 Ranch in Brewster County.

Plateilema palmeri (A. Gray) Cockrell has been known only from a few localities in Coahuila and Nuevo León, Mexico and historically from Brewster County, Texas (Turner 2000; Powell & Spellenberg 2013). It is the only representative of the genus, which is positioned in the tribe Heleniеae (Strother 2006).

Until recently, the species had remained unobserved in the United States for more than 85 years. Within the USA, prior documentation was known only from specimens collected in west-central Brewster County, Texas, by Henry T. Fletcher in April 1929. At that time, Fletcher was a manager and partner of the O2 Ranch, located ca. 50 km south of Alpine, Texas (Keller 2005) (Fig. 3A). Fletcher possessed a keen interest in botany and collected many specimens from the area, mostly now deposited at SRSC (Turner 2000; Powell & Spellenberg 2013). Fletcher collected two specimens of *Plateilema palmeri* on the same day, according to specimen labels (Turner 2000). Both collections were made ca. 70 km south of Alpine, Texas, on what is now the O2 Ranch (10 Apr 1929, *H.T. Fletcher 219*, SRSC; 10 Apr 1929, *H.T. Fletcher 884*, SRSC).

On 12 August 2014, Sul Ross State University graduate student Chris Jackson rediscovered a group of individuals of the species growing within an experimental vegetation plot on the O2 Ranch. This population was located ca. 4 km west of one of the Fletcher collections (*Fletcher 219*). As part of a long-term grassland restoration study, Jackson was performing vegetation surveys and identifying all broad-leaved, herbaceous plants found within experimental plots. Identification

proved initially unsuccessful as *Plateilema palmeri* is not included in the Manual of the Vascular Plants of Texas (Correll & Johnston 1970), but the specimen subsequently was brought to the attention of the second author, who identified it as *P. palmeri*. The voucher label data are included here.

> **Texas. Brewster Co.:** ca. 70 km S of Alpine, ca. 4 km W of TX 118, O2 Ranch, elev. 1143 m, fine clay deposits within a broad, alluvial basin ("tobosa flats") near base of *Prosopis glandulosa* var. *torreyana* and along edge of perennial grass community in debris deposited by recent overland flows, other associates include *Larrea tridentata, Parthenium confertum, Flourensia cermua, Cylindropuntia leptocaulis, Pleuraphis mutica, Hopia obtusa, Setaria leucopila, Muhlenbergia arenacea, Scleropogon brevifolius, Bouteloua curtipendula, Hoffmanseggia glauca, Acourtia nana, Senna pumilio, Chamaesyce serrula,* and *Heliotropium greggii*, 12 Aug 2014, *C. Jackson 170* (SRSC).

The area where *Plateilema palmeri* individuals have been documented on the O2 Ranch lies within a broad, alluvial basin known locally as the Green Valley. The Green Valley is characterized vegetatively as Chihuahuan Desert Scrub (Powell & Spellenberg 2013); physiognomy is that of a desert grassland (tobosa flats). Common species observed here include *Bahia absinthifolia, Flourensia cermua, Parthenium confertum, Heliotropium greggii Cylindropuntia leptocaulis, Prosopis glandulosa* var. *torreyana, Sphaeralcea angustifolia, Oenothera suffrutescens, Muhlenbergia arenacea, Pappophorum vaginatum, Pleuraphis mutica, Scleropogon brevifolius, and Larrea tridentata*. The structure of the vegetation community in this area often forms banded vegetation patterns (Fig. 4A), which are discrete, elongated patches of vegetation occurring on landforms with very low slopes (ca. 1%), oriented in parallel to the slope contour and typically occurring in arid and semiarid areas (Warnock 1997; d'Herbès et al. 2001). Banded vegetation may be the preferred habitat for *P. palmeri* (Fig. 4B), because the most robust specimens and largest groups have been found within these microhabitats (Fig. 5A).

Jackson was accompanied by A.M. and Shirley Powell in following field outings. Their collections of flower buds from *Plateilema palmeri* specimens within an area of ca. 1,288 hectares on the 02 Ranch yielded chromosome counts from four populations. The chromosome number is identical to that first reported for a population in Coahuila, Mexico (Powell & Spellenberg 2013). Buds were fixed in Modified Carnoy's solution (4:3:1; chloroform: absolute ethanol: glacial acetic acid). Meiotic chromosome counts were made by the second author. Voucher specimens for chromosome counts (SRSC) are indicated here.

> **$2n = 26$ (13II)**, all four populations. Brewster Co.: (1) ca. 70 km S of Alpine, ca. 4 km W of TX 118, O2 Ranch, 15 Aug 2014, *Powell & Powell* and *Jackson 7108*; (2) ca. 70 km S of Alpine, ca. 4 km W of TX 118, O2 Ranch, ca. 100 m E of site for *Powell et al. 7108*, 15 Aug 2014, *Powell & Powell* and *Jackson 7111*; (3) ca. 62 km S of Alpine, ca. 1 km W of TX 118, O2 Ranch, 30 Aug 2014, *Powell & Powell, Jackson,* and *Jones 7143;* (4) ca. 64 km S of Alpine, E of TX 118, O2 Ranch, 14 Sep 2014, *Powell & Powell, Jackson,* and *B. Warnock 7149.*

Since the rediscovery, Jackson has continued work in documenting the distribution of *Plateilema palmeri* on the O2 Ranch. To date, ca. 1,800 individual plants have been located within an area spanning ca. 4,047 hectares. Current mapping of *P. palmeri* populations suggests that distribution may be limited to fine, clay loam soils deposited from calcareous parent materials, mainly from marl, mudstone, shale, limestone, and calcareous tuffs deposited during the Cretaceous-Paleogene Periods (K/PG boundary) (Goldich & Elms 1949; USDA 2013). The majority (~98%) of individuals have been documented in the Cesario and Fizzleflat loam soils within the Loamy Desert Grassland ecological site, R042XC250TX (Fig. 3B) (USDA 2012).

Figure 1. Habit of *Plateilema palmeri*. A. Initial voucher specimen collected on 12 Aug 2014. B. Group of individuals growing in area treated by prescribed fire beneath burned *Prosopis glandulosa* var. *torreyana*. C. Example of large basal rosette with evidence of herbivory (*Jackson 286*, SRSC). D. Example of contrast in size of individuals; coin is a USA quarter.

Figure 2. A. Habit of very small individual of *Plateilema palmeri*. B. Habit of individual with long peduncle (*Jackson 218*, SRSC). C. Example of individual with multiple heads. D. Male long-horned bee visiting *P. palmeri* at anthesis; bee identified tentatively as *Melissodes* sp.

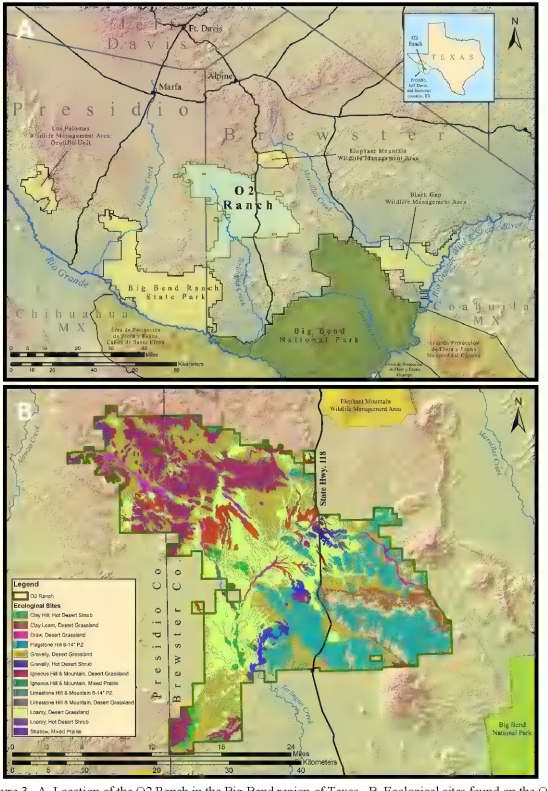

Figure 3. A. Location of the O2 Ranch in the Big Bend region of Texas. B. Ecological sites found on the O2 Ranch. *Platelema palmeri* plants have been documented primarily in the Loamy Desert Grassland Ecological Site (indicated by light green color).

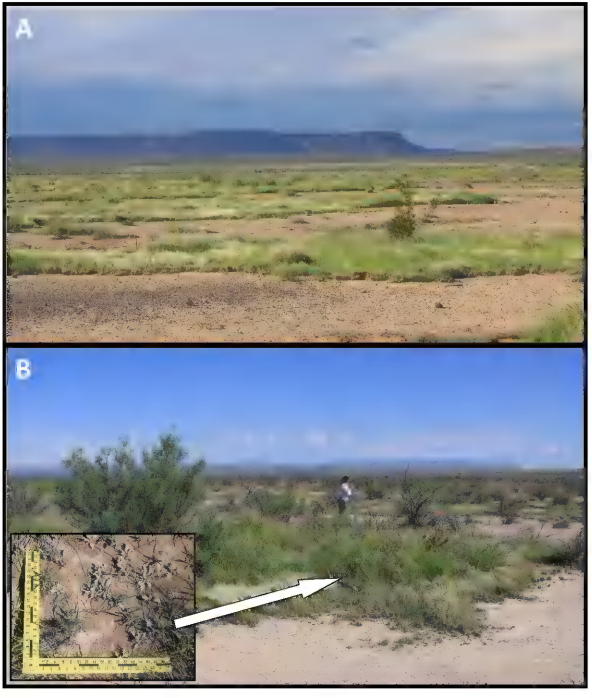

Figure 4. A. Example of banded vegetation pattern and habitat of *Plateilema palmeri* in the Green Valley (O2 Ranch); prior to restoration treatments, this rangeland was impacted by woody plant encroachment. B. Further example of banded vegetation habitat, *P. palmeri* often found growing within small clearings (inset) in banded vegetation.

Figure 5. A. Robust group of *Plateilema palmeri* growing in open space within banded vegetation. B. Mature head lying on the soil surface; peduncle collapse appears to be the common aspect at maturity. C. Mature cypselae and heads.

Plans for further study of *Plateilema palmeri* on the O2 Ranch include further mapping of species distribution, documenting presence/absence within additional soil types and ecological sites, pollination ecology, species dispersal and recruitment, documentation of herbivory, soil analysis and moisture requirements, and chemical analysis of plant tissues. Jackson is currently proposing a biological study of *P. palmeri* to meet the requirements of his Master's thesis under the direction of Bonnie J. Warnock.

A large number of documented individuals of *Plateilema palmeri* occur within restoration treatment areas on the O2 Ranch. It is unclear if these treatments may influence the presence or abundance of this species, yet it may be safe to assume that this species can withstand disturbance, because mechanical grubbing, tebuthiuron treatments, and prescribed burning have been implemented within areas of known *P. palmeri* distribution on the O2 Ranch. Additionally, livestock are present within this area, although stocking rates are kept at a sustainable level (Bonnie J. Warnock, pers. comm., 1 Jul 2014). It is fortuitous that the owners of the O2 Ranch, Lykes Bros. Inc., have the foresight to use sound land stewardship principles in their management of this vast, privately owned ranch and have partnered with Warnock (Sul Ross State University) in restoring a degraded ecosystem in the biologically diverse, northern Chihuahuan Desert.

ACKNOWLEDGEMENTS

We thank the owners of the O2 Ranch, Lykes Bros. Inc., for the opportunity to study this little-known species. We extend our gratitude to the O2 Ranch manager, Homer Mills, for his commitment towards improving the ecological integrity of the O2 Ranch and in facilitating access to additional sections of the ranch. Special thanks to Shirley Powell and Isabel Jones for assistance in field work, Dr. Robert Kinucan for reviewing the article, Dr. Guy Nesom for improvements to the manuscript, and Borderlands Research Institute for providing necessary equipment and vehicles for travel for this continuing study.

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Santamaría-A, D., N. Zamora V., y R. Aguilar F. 2015. Sinopsis del género *Laetia* (Salicaceae) en Mesoamérica y la descripción de una nueva especie. Phytoneuron 2015-15: 1–19. Published 3 March 2015. ISSN 2153 733X

SINOPSIS DEL GÉNERO *LAETIA* (SALICACEAE) EN MESOAMÉRICA Y LA DESCRIPCIÓN DE UNA NUEVA ESPECIE

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RESUMEN

Se presenta una sinopsis del género *Laetia* (Salicaceae) para Mesoamérica. Se reconocen cuatro especies, incluida *L. micrantha*, *L. procera*, *L. thamnia*, y ***Laetia povedae*** N. Zamora, Aguilar, & D. Santam., **sp. nov.**, de Nicaragua, Costa Rica, y Panamá.

Laetia Loefl. ex L. (Salicaceae) se distribuye desde el Sur de México y América Central, América del Sur, y las Antillas. Este género se encuentra constituido por 11 especies (incluída la aquí descrita), de las cuales cuatro son conocidas en Mesoamérica. El género se reconoce por las ramas y troncos sin espinas, hojas alternas, dísticas, con la venación pinnada, la lámina generalmente con puntos o líneas translúcidos y el margen entero o crenado, flores bisexuales, sin disco y pétalos, con estambres numerosos y ovario súpero, y frutos capsulares carnosas (semejando bayas), tardiamente dehiscentes y con semillas ariladas (Alford 2003; Alford & Belyaeva 2009).

Clave para las especies de *Laetia* en Mesoamérica

1. Inflorescencias de fls. fasciculadas; sépalos 5; filamentos y frutos (no observados en *L. micrantha*) glabros.

2. Láminas foliares serruladas, la base oblicua obtusa a redondeada en un lado y aguda a obtusa en el otro lado), el ápice largo-acuminado; pedicelo 2.0–4.0 mm de longitud; estilo trífido ..... **Laetia micrantha**
2. Láminas foliares crenadas o aserradas, la base redondeada, truncada o subcordada, el ápice corto-acuminado; pedicelo 5.0–12 mm de longitud; estilo entero ..... **Laetia procera**

1. Inflorescencias cimas corimbosas; sépalos 4; filamentos y frutos pubescentes.

3. Láminas foliares con el margen siempre entero, comunmente oblongas y largo-pecioladas ..... **Laetia povedae**
3. Láminas foliares con el margen siempre crenado o débilmente crenulado, comúnmente elípticas y corto-pecioladas ..... **Laetia thamnia**

1. LAETIA MICRANTHA A. Robyns., Ann. Missouri Bot. Gard. 54: 190. 1967.

Laetia micrantha se diferencia muy fácilmente de las otras especies de *Laetia* en Mesoamérica por sus hojas angostamente ovadas a oblongas, con el margen marcadamente serrulado, la base obtusa y evidentemente oblicua, el ápice largo-acuminado, y el haz y el envés con pequeñas y esparcidas líneas negras; sus inflorescencias en fascículos axilares, muy densos, con pedicelos delgados; y sus flores con 10 estambres, con los filamentos y el ovario glabros.

Distribución. Endémica de la provincia de Darién, Panamá, entre los 500 y 533 m de elevación.

Fenología. Flores han sido recolectadas en junio y julio; frutos no observados.

Nombre común. Raspalengua (Panamá).

Usos ■ historia natural. Los frutos se reportan como comestibles y la madera cuando seca es utilizada para leña (*Duke & Bristan 238,* MO).

Iconografía. Robyns (1968: 129, fig. 11).

Especímenes examinados. PANAMÁ. Darién. On hills above W end of airstrip at Cana near Río Cana, 07°45'N, 077°41'W, 500 m, 31 Jul 1976 (fl), *Croat 38064* (MO); vicinity of airstrip at Cana gold mine, 07°45'N, 077°41'W, 29 Jul 1976 (fl), *Croat 38000* (MO); Perrecenico River, Jun 1996 (fl), *Duke & Bristan 238* (MO); trail between Paya & Palo de las Letras, 10 Jun 1959 (fl), *Stern et al. 206* (GH-2 cartulinas); vicinity of Cana, 533 m [1750 feet], 24 Jun 1959 (fl), *Stern et al. 513* (MO).

2. LAETIA POVEDAE N. Zamora, Aguilar, & D. Santam., **sp. nov. Tipo. COSTA RICA. Alajuela.** Cantón de San Carlos. Pital, Llanura de San Carlos, ca. 13 km NE de Boca Tapada, Finca Aserradero, San Jorge,10°44′54″N, 84°10′07″W, 50 m, 20 Jun 1996 (fl), *B. Hammel, A. Rodríguez, & N. Zamora 20240* (holotipo: CR!; isotipos: INB!, MO!). Figuras 1–4.

The new species is most similar to and has been confused with *Laetia thamnia* L., from which it differs chiefly by its long-petiolate leaves with the lamina commonly oblong and with entire margins and (vs. short-petiolate leaves with the lamina commonly elliptic and with crenulate to subcrenulate margins.

Árbol (5–) 15–30 × 0.1–0.45 m; tronco cilíndrico y sin gambas, la corteza externa lisa, grisácea; **ramitas** rojizas, levemente aplanadas distalmente, glabras, longitudinalmente estriadas y densamente lenticeladas, las lenticelas elípticas o redondeadas, blanquecino-grisáceas. **Hojas** alternas, dísticas, con pecíolos de (0.3–) 1.0–1.5 (–1.7) cm de longitud, generalmente cilíndricos, algunas veces levemente sulcados, glabros; estípulas 0.05–0.1 cm, amplio-deltoides a triangulares, persistentes o caducas, el margen entero o ciliado; láminas foliares (7.3–) 11–16 (–19) × (2.7–) 4.0–6.3 (–6.5) cm, oblonga u oblongo-elíptica a obovada; base obtusa a algo asimétrica; ápice acuminado o corto acuminado, mucronado; margen entero; el haz y el envés glabros, generalmente con puntos o líneas translúcidas; venación broquidódroma, visible en el envés; venas laterales 11–13 por lado, distanciadas ca. 0.9–1.1 cm, planas o impresas en el haz, redondeados y elevados en el envés; venas terciarias destacadas sobre ambas superficies. **Inflorescencias** generalmente axilares o supra-axilares en la misma rama, cimas corimbosas (con hasta 6 flores); pedúnculo (1.8–) 3.5–4.7 cm de longitud, cilíndrico o aplanado, glabro; pédicelos (0.5–) 0.8–1.3 cm de largo, articulados de 0.1–0.2 mm de la base, cilíndricos, glabros; brácteas y bracteolas semiorbiculares a ampliamente triangulares, glabras a glabrescentes, quilladas, el margen ciliado, el ápice redondeado o acuminado, persistentes; brácteas libres, las bracteolas unidas o separadas. **Flores** blancas, con aroma dulce, bisexuales; sépalos 4, libres, imbricados, 0.8–1.0 × 0.5–0.6 cm, oblongos, petaloides, sin líneas o puntos, reflexos, caducos;

sépalos externos glabros en la superficie externa (excepto hacía el margen y el ápice con una pubescencia densa café), los márgenes ciliados y cartáceos, el ápice redondeado a agudo, la superficie interna similar a la externa o densamente pubescente; sépalos internos similares en forma y tamaño a los externos, pero con la superficie externa densamente pubescente hacía la parte central y glabro hacía el margen, la superficie interna esparcidamente pubescente (y algunas veces formando líneas longitudinales de tricomas) a glabrescente, los márgenes ciliados y membranáceos; estambres ca. 225+, desiguales; filamentos libres, 1.0–5.0 mm de longitud, filiformes, más o menos aplanados, esparcido-pubescentes, blancos; ovario ca. 1.5 mm de longitud, redondeado a ampliamente ovoide, densamente pubescente (los tricomas café-amarillentos a dorados), atenuado hacía el ápice, la columna del estilo ca. 1.0–2.0 mm de longitud, glabra; estigma capitado. **Frutos** ca. 1.3 (inmaduros)–3.7 × 0.9–4.0 cm (–8.0 cm, en material fresco; *González & Sánchez 177*, INB), globosos, con la superfice externa cubierta por una pubescencia densa, pardo-rojiza a ferrugínea, el interior rojo, rosado, escarlata o blanco-rosado, carnosos, dehiscentes; pericarpo ca. 1.0–6.0 mm de grueso, duro. **Semillas** ca. 0.5–0.7 × 3.0–4.0 cm, más o menos redondeadas o de forma irregular, obtusas hacía el ápice, café claro cuando secas (con el arilo amarillo), glabras.

Laetia povedae se caracteriza generalmente por su hábito de árbol de gran tamaño, con las ramitas rojizas, aplanadas distalmente, con numerosas y pequeñas lenticelas; sus hojas dísticas, la lámina comunmente oblonga, con el ápice mucronado, el margen siempre entero (tanto en individuos juveniles como adultos) y la venación broquidódroma visible y conspicua en el envés; sus inflorescencias en cimas corimbosas con el pédunculo relativamente largo; sus flores con numerosos estambres, con los filamentos esparcido-pubescentes; y sus frutos grandes, globosos, con la superfice externa cubierta por una pubescencia densa, pardo-rojiza a ferrugínea, e internamente con un color escarlata intenso (cuando abiertos y recien caídos al suelo).

Laetia povedae durante muchos años fue confundida e incluida en algunos tratamientos florísticos bajo el concepto de *Laetia thamnia* L. (p. ej. Pool & Smith 2001; Quesada et al. 1997; Sleumer 1980). Pero, *L. povedae* se puede separar claramente de *L. thamnia* por las características antes indicadas en la clave. También, *L. povedae* tiene inflorescencias con el pédunculo más largo: (1.8–) 3.5–4.7 cm de longitud, vs. 0.5–1.7 cm de longitud en *L. thamnia*. Además, en general, las hojas de *L. povedae* tienden a ser más grandes y con pecíolos más largos [1–1.5 (–1.7) cm], mientras, en *L. thamnia* (según el concepto del tipo) son relativamente más pequeñas y con pecíolos más bien cortos.

La única especie conocida de *Laetia* con láminas foliares con los márgenes enteros e inflorescencias en cimas corimbosas es *Laetia ternstroemioides* Griseb., de Cuba, pero ésta tiene láminas foliares con el ápice redondeado o emarginado y los márgenes revolutos (vs. ápice acuminado o corto-acuminado y los márgenes no revolutos en *L. povedae*) y flores con ca. 20 estambres, con los filamentos glabros (vs. flores con ca. 225 estambres y los filamentos esparcido-pubescentes en *L. povedae*). *Laetia americana* L. y *L. corymbulosa* Spruce ex Benth. también comparten con *L. povedae* inflorescencias en cimas corimbosas, pero difieren por tener los márgenes foliares serrulados o diminutamente dentados y flores con los filamentos glabros.

En cuanto al tipo de habitat o ecosistema, *Laetia povedae* se conoce principalmente de bosques muy húmedos de elevaciones bajas, a excepción en Panamá, donde también alcanza el bosque nuboso de elevaciones medias; la mayoría de las recolecciones provienen de la vertiente Caribe, excepto en Costa Rica donde varias son del Pacífico sur (en especial de la Península de Osa). En cambio, *L. thamnia* ocurre principalmente en bosques secos decíduos a semidecíduos o siempre verde estacionales; según recolecciones (ver especímenes examinados), al norte de Costa Rica su distribución geográfica es variable, y al parecer solo en Costa Rica y Panamá es restringida a la costa Pacífica.

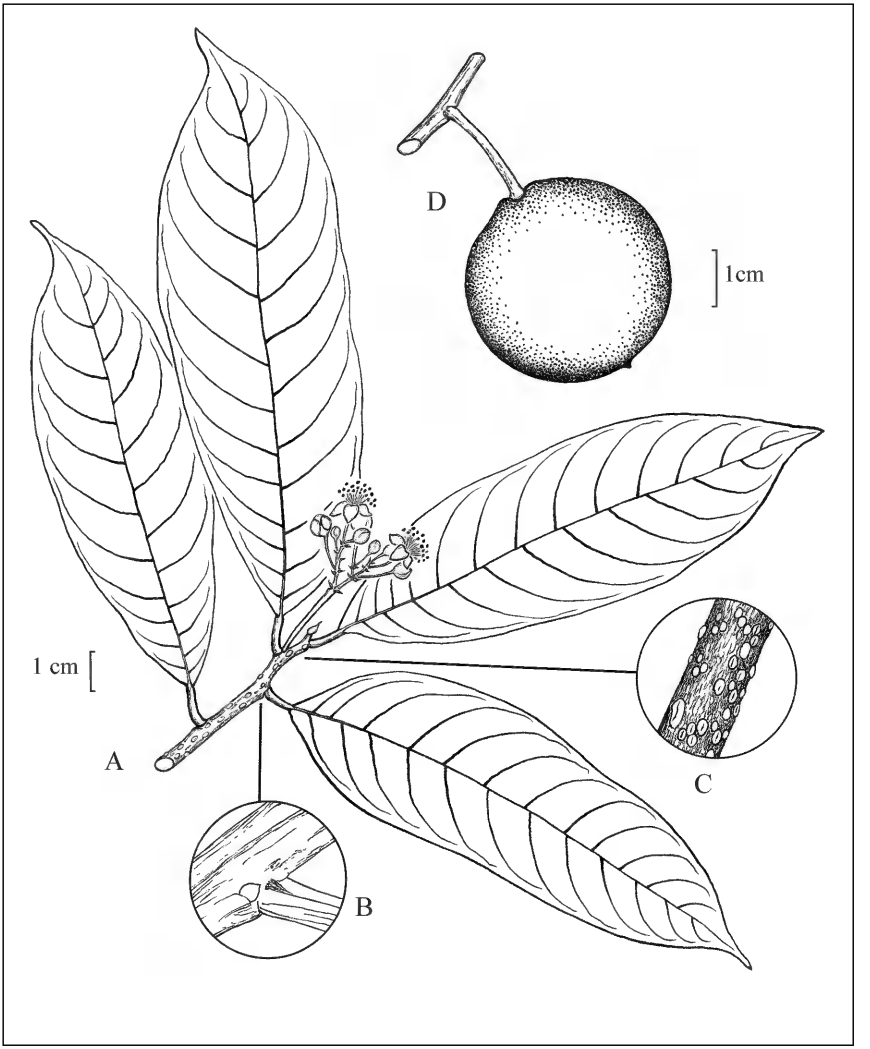

Figura 1. *Laetia povedae*. **A.** Ramita con flores. **B.** Detalle de la estípula. **C.** Detalle de lenticelas. **D.** Fruto. (**A–C,** de *Hammel et al. 20240*, INB; **D,** de *Jiménez et al. 1128*. INB. Dibujo por Claudia Aragón. Tomado, con permiso, de Zamora et al. (2012).

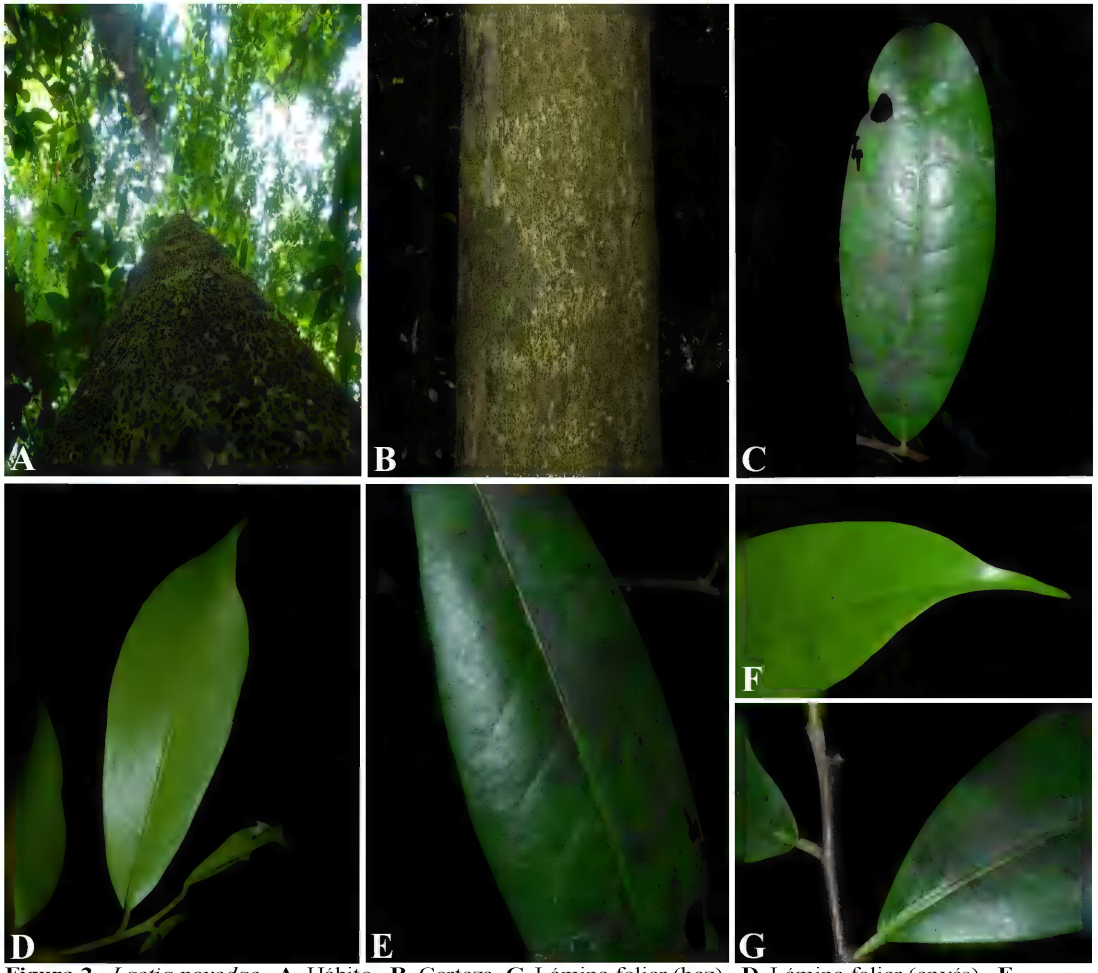

Figura 2. *Laetia povedae*. **A**. Hábito. **B**. Corteza. **C**. Lámina foliar (haz). **D**. Lámina foliar (envés). **E**. Lámina foliar (margen). **F**. Lámina foliar (ápice). **G**. Lámina foliar (base). (**A–G**, de *Aguilar 5147*, INB). Fotos por R. Aguilar.

Material de herbario de *L. povedae*, en particular aquel preservado previamente en alcohol, tiene una coloración o tonalidad pardo-rojiza o pardo oscura característica; mientras, que en *L. thamnia* su coloración es más bien grisácea o grisáceo-palida.

En el tratamiento de Flacourtiaceae para el *Manual de Plantas de Costa Rica* (González 2010), y el libro *Árboles de Costa Rica* (Zamora et al. 2012), *Laetia povedae* fue tratada como *Laetia* sp. A.

Figura 3. *Laetia povedae*. **A**. Rama con flor. **B**. Inflorescencia. **C**. Vista lateral de los botones florales y flor abierta. **D**. Estambres y ovario. (**A–D**, de *Aguilar 5147*). Fotos por R. Aguilar.

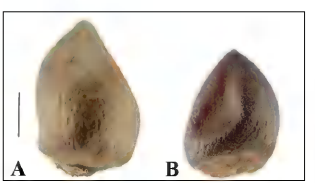

Figura 4. Semillas. **A**. *Laetia povedae*. **B**. *Laetia thamnia*. (**A**. de *Morales 5505*, INB). **B**. de *Robles 2153*, INB). Escala= 2 mm. Fotos por J. Mata-Lorenzen.

Distribución. Nicaragua (Río San Juan), Costa Rica (Alajuela, Limón y Puntarenas) y Panamá (Colón, Panamá, San Blas, Veraguas). Se ha recolectado en bosques muy húmedos, entre 0–350 m de elevación, y en bosques nubosos (en Cerro Jefe y Cerro Tute, Panamá) entre 650–1200 m de elevación.

Fenología. Flores han sido recolectadas de mayo a agosto; frutos en abril, de junio a octubre y diciembre.

Nombre común. Pata de Yanki.

Etimología. Es un gran honor dedicar esta especie a nuestro querido amigo y maestro Luis Jorge Poveda Álvarez (1945–) quién realizó la primer colección en Costa Rica (en 1973) de la especie que aquí le dedicamos. Además, deseamos que sea este un reconocimiento por sus múltiples e importantes aportes a la botánica y etnobotánica costarricense.

Usos o historia natural. En Costa Rica los frutos de *Laetia povedae* se reportan como astringentes (*Poveda 731*, CR, MO) y comidos por monos (*Robles 2153*, INB, MO).

Especímenes examinados. NICARAGUA. Río San Juan. Sábalo, 3 km del enlace del Río San Juan y el Río Sábalo, 11°04'N, 084°27'W, 40–50 m, 26 Set 1982 (fr), *Araquistain 3212* (MO); 2 km al NW del Río Santa Cruz, 11°03'N, 084°25'W, 70 m, 24 Feb 1984 (fl), *Moreno 23346* (MO); Buenos Aires, 1 km N del caserío de Sábalo, sobre el Río Sábalo, 11°02'N, 084°28'W, 70 m, 10 Set 1985 (fr), *Moreno 26323* (MO); Boca de Sábalo; bosque siempreverde, 11°02'30"N, 084°28'00"W, 70–100 m, 14 Mar 1987 (bot. fl), *Moreno 26831* (MO); sobre el Río Sábalo, 11°03'N, 84°28'W, 40 m, 07–08 Jul 1984 (bot. fl), *Moreno & Robleto 26032* (MO); Municipio el Castillo, Río San Juan, Reserva Indio-Maíz, Cerro el Diablo, 11°01'N, 084°12'W, 250–350 m, 08 Dic 1998 (fr), *Rueda et al. 9596* (MO); refugio Bartola, 10°58'N, 084°20'W, 60 m, 15 Feb 2005 (est), *Rueda et al. 17861* (MO), *17934* (MO); La Lupe, ca. 25 km ENE of Boca de Sabalo, 28 Jun 1997 (est), *Salick & Stijfhoorn 8304* (MO); Comunidad Dos Bocas Bartola, alrededores del puesto de control, 11°00'08"N, 084°16'31"W, 100 m, 29 Abr 2005 (bot. fl), *Urbina 3344* (MO). **COSTA RICA. Alajuela**. Cantón de San Carlos, Pital. Boca Tapada, Finca Hogar de Ancianos, 10°42'00"N, 084°10'00"W, 20 m, 10 Oct 1992 (fr), *Jiménez et al. 1128* (CR, F, INB, MO). **Limón.** Matina, en la vera del Río Madre de Dios, 17 Oct 1973 (CR [est]; MO [fr]), *Poveda 731* (CR, MO); Cantón de Pococí, Colorado, Parque Nacional Tortuguero, aprox. 2 km N del pueblo rumbo a la Barra de Colorado, 10°33'00"N, 083°31'00"W, 4 m, 15 Jun 1994 (fr), *Robles 2153* (INB, MO); Cantón de Talamanca, Amubri, Camino entre Amubri y Soki, siguiendo las filas que conducen al Alto de Soki, 09°29'50"N, 082°59'10"W, 150 m, 30 Jun 1989 (fl), *Herrera 3089* (CR, MO); Reserva Indígena Talamanca Bribrí, Valle de Talamanca, inmediaciones de la falda sur de la Fila Carbón, 09°37'30"N, 082°49'50"W, 250 m, 01 Ago 1994 (fr), *González & Sánchez 177* (CR, INB). **Puntarenas.** Cantón de Golfito, Puerto Jiménez, Río Piro, camino a Cerro Osa, 08°24'00"N, 083°17'00"W, 50 m, 17 Oct 1990 (est), *Chacón 1128* (CR, INB, MO); Cantón de Osa, Sierpe, Reserva Forestal Golfo Dulce, Península de Osa, entre Rancho Quemado y Drake, 5 km antes del Progreso, 08°40'44"N, 083°34'00"W, 200 m, 28 May 1997 (fl), *Aguilar 5147* (CR, INB, MO); Cantón de Osa, Sierpe, Reserva Forestal Golfo Dulce, 08°42'00"N, 083°31'00"W, 50 m, 18 Ago 1992 (fr), *Aguilar 1266* (CR, INB, MO); Cantón de Osa, Sierpe, Punta Pargo (cerca del Alto de los Mogos), 24 Jul 1987 (fr), *Sánchez & Poveda 1270* (CR, MO); Cantón de Osa, Sierpe, Reserva Forestal Golfo Dulce, Península de Osa, Los Mogos, 08°46'20"N, 083°22'40"W, 200 m, 05 Jul 1994 (fr), *Aguilar 3465* (CR, INB, MO); Rincón, Península de Osa, Reserva Forestal Golfo Dulce, Vanegas de Rincón de Osa, camino a Rancho Quemado, cruce a Baneguitas bosques alrededor Finca de Isidro Guido, 08°40'42"N, 083°31'43"W, 100 m, 18 Jul 2013 (est), *Zamora et al. 6437* (INB). **PANAMÁ. Colón**. Camino a la zona maderera de Santa Rita, 09°19'N, 079°39'W, 30 Jul 1968 (fr), *Correa & Dressler 915* (MO, PMA); on Río Miguel de la Borda near Guasimo, 09°09'N, 80°20'W, 22 Abr 1970 (fr), *Croat 9881* (MO); Salud, 5 m, 04 Ago 1971 (fl),

Lao & Holdridge 228 (MO, PMA). **Panamá**. Región de Cerro Jefe, Area cercana al límite con la Urbanización Altos de Cerro Azul, 09°14'N, 079°21'W, 800–1000, 13 Jul 1994 (bot. fl), *Galdames & Montenegro 1413* (MO, PMA); Cerro Jefe, near area called Los Nubes, along old road towards river, 09°15'N, 079°30'W, 650 m, 19 Jul 1987 (fr), *McPherson 11299* (MO, PMA); Cerro Jefe, along new small road S of road to Alto Pacora, 09°15'N, 079°30'W, 850 m, 10 Oct 1992 (fr), *McPherson & Richardson 15862* (MO, PMA); vicinity of Cerro Jefe, 09°15'N, 079°30'W, 650 m, 27 Ago 1986 (fr), *McPherson 9997* (MO, PMA); Cerro Azul to Cerro Jefe, 09 Jul 1966 (fl), *Tyson et al. 4313* (MO-2 cartulinas); Cerro Jefe, Altos de Pacora ± 1 km de Cabaña 4 x 4, 09°13'27"N, 079°21'36"W, 20 Ago 2008 (fl), *Galdames et al. 6252* (MO, PMA); Cerro Jefe, 1000 m, 22 Set 1972 (fr), *Gentry 6141* (MO). **San Blas**. Tierra firme frente a Isla de Miria Ubigandup camino de Sangandi, 09°26'N, 078°54'W, 0–20 m, 21 Jul 1987 (fr), *Herrera & Pérez 302* (MO, PMA); Playón Chico and vicinity, Pinkanti, 09°18'N, 078°14'W, 07 Jul 1975 (fl, fr), *Stier 186A* (MO); Isla Pino, near Mulatupo Island, ca. 3–4 mi by 1 mi broad, 09°00'N, 077°45'W, 60 m [200 ft], 16 Ago 1967 (fr), *Elias 1700* (MO); cordillera frente a Isla Narganá, quebrada afluente de Río Diablo, 09°22'N, 078°34'W, 65 m, 12 Ago 1994 (fr), *Galdames et al. 1577* (MO, PMA). **Veraguas**. Santa Fe, Cerro Tute, 08°28'56"N, 81°05'53"W, 1200 m, 28 Set 1972 (fr), *Lao & Gentry 533* (MO, PMA-2 cartulinas).

3. LAETIA PROCERA (Poepp.) Eichler en Mart., Fl. Bras. 13: 453. 1871. *Samyda procera* Poepp., Nov. Gen. Sp. Pl. 3: 67. 1845. Figura 5.

Laetia procera se distingue por sus hojas disticas, la lámina oblonga a elíptico-oblonga, con la base redondeada, truncada o subcordada, el margen siempre crenado o finamente aserrado y numerosos puntos o líneas pelúcidas; sus inflorescencias de flores fasciculadas o supra-axilares; sus flores con los filamentos y ovario glabro; y sus frutos globosos a elipsoides, glabros, con los sépalos persistentes (en los frutos inmaduros) y numerosos semillas, cubiertas por un arilo blanco. Adicionalmente, llegan a ser árboles de hasta 40 m de altura, con la corteza externa densamente suberosa-lenticelada y ramas agrupadas en el ápice del tronco o ramas principales.

Fenología. En América Central las flores han sido recolectadas de enero a marzo, mayo, junio y setiembre; frutos de enero a junio, agosto y setiembre.

Nombre común. Drunken bayman wood, May-t (Belice); Areno (Nicaragua); Areno, Jabón, Liwa, Manga larga, Tambor (Honduras); Camarón, Espino amarillo, Manga larga, Manga larga roja, Mangalarga, Mangalarga blanca, Mangalarga colorada, Mangle, Mangle Camarón (Costa Rica); Corta lengua, Manga larga, Pica lengua (Panamá).

Distribución. Guatemala (Izabal), Belice, Honduras (Atlántida y Gracias a Dios), Nicaragua (Atlántico Norte, Bluefields y Río San Juan), Costa Rica (Alajuela, Heredia, Limón, Puntarenas, San José) y Panamá (Colón y Panamá), y de Colombia hasta Bolivia y Brasil y también en las Antillas. Crece en bosques muy húmedos, comúnmente entre los 0–100 m de elevación, aunque también se ha recolectado entre 200–500 m.

Usos n historia natural. En Costa Rica los frutos de está especie son comidos por la ave *Tachyphonus luctuosus* [Thraupidae] (*Solano 1092*, INB) y las hojas son comidas por las larvas de la mariposa *Zaretis itys* [Nymphalidae] (Flórula Digital de la Estación Biológica La Selva, 2013). En Honduras se utiliza para leña verde, postes y vigas de ranchos (*House 2035*, *2076*, MO). La madera tratada puede utilizarse en construcción pesada, carpintería y construcción interna y externa, y para impletos agrícolas, postes de cerca, pisos y muebles, además de pulpa para papel, entre otros usos (Flores-Vindas & Obando-Vargas 2003).

Iconografía. Zamora (2000: 232); González (2010: 801); Condit et al. (2011: 421).

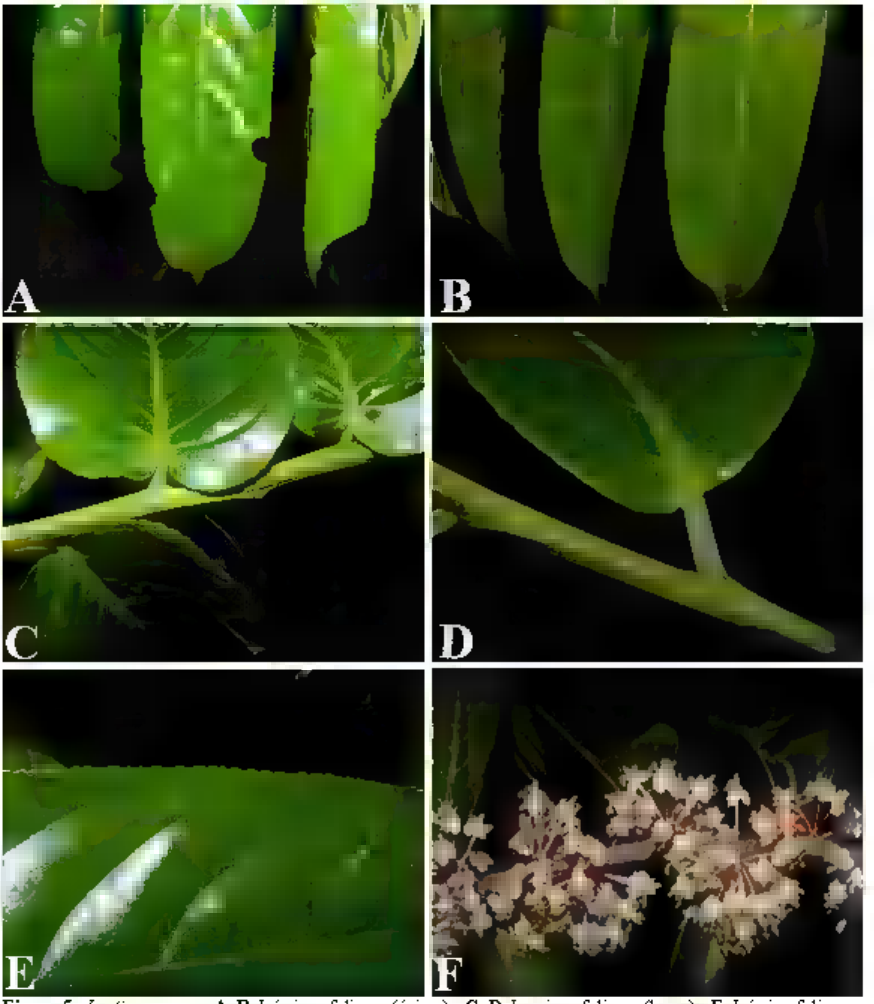

Figura 5. *Laetia procera*. **A, B.** Láminas foliares (ápices). **C, D.** Laminas foliares (bases). **E.** Lámina foliar (margen). **F.** Inflorescencias. Fotos por R. Aguilar.

Especímenes examinados. BELICE. Stann Creek Valley, Big Eddy Ridge, 27 Abr 1940 (est), *Gentle 3320* (A); Mountain Cow Ridge, 31 Mar 1940 (fl), *Gentle 3297* (A, MO-2 cartulinas). **GUATEMALA**. **Izabal.** Puerto Méndez-Cadenas, on Toquela River road, 5 km from the village, 06 Set 1969 (fr), *Contreras 9079* (MO); puerto Méndez-Cadenas, km 9 on Toquela Road, 12 Jun 1970 (fr), *Contreras 10030* (MO); puerto Méndez-Cadenas, on Río Dulce road, bordering Río Sehila, km 28, 21 Set 1970 (fl), *Contreras 10322* (MO); Puerto Méndez, on Río Dulce road, Cienaga, km 26, 20

Set 1970 (fl), *Contreras 10316* (MO). **HONDURAS**. **Atlántida.** Hills above Santiago River, watershed between La Masica and La Ceiba, 5 km S of paved road, 300–500 m, 07 Set 1979 (fr), *Hazlett 3282* (CR, F); Cerro Poza Oscura, Santiaguito, La Ceiba, 450 m, 06 Jun 1997 (fr), *Díaz 29 S–1* (MO). **Gracias a Dios**. Cerro wimpi, Krausirpe, 15°03'N, 084°50'W, 90 m, 21 Mar 1994 (fl), *House 2035* (MO); bosque primario 40 mins N de Krausirpe, 15°03'N, 084°50'W, 90 m, 07 Ago 1994 (fr), *House 2076* (MO). **NICARAGUA**. **Atlántico Norte**. Sur de Río Wawa, 60 km NO de Puerto Cabezas, 14°19'N, 083°56'W, 40 m, 13 Mar 1971 (est), *Little 25133* (MO). **Bluefields**. Base Camp 3.6 km SE Cerro San Isidro, Río Kama, Río Escondido, 65 m, 17 Mar 1966, *Proctor 27163* (CR); Río San Juan, camino al campamento La Lupe ca. 12.5 km al NE del poblado El Castillo, 100 m, 04 Dic 1991 (bot. fl), *Grijalva 5620* (CR). **Río San Juan**. Buenos Aires, 1 km al N del caserío de Sábalo, sobre el Río Sábalo, 11°02'N, 084°28'W, 70 m, 10 Set 1985 (fr), *Moreno 26298* (MO); 2 km al NW del Río Santa Cruz, 11°03'N, 084°25'W, 20 m, 24 Feb 1984 (fl), *Moreno 23329* (MO); municipio del Castillo, Estación Biológica La Lupe, 11°08'N, 084°21'W, 50–60 m, 03 Dic 1999 (est), *Rueda et al. 12390* (MO); reserva Indio-Maíz, Municipio del Castillo, estación experimental La Lupe, 11°07'N, 084°22'W, 100 m, 22 Nov 2000 (est), *Rueda et al. 15092* (MO). **COSTA RICA**. **Alajuela**. San Carlos, Pital, ca. 7 km NE de Boca Tapada, Laguna del Lagarto Lodge, 10°41'10"N, 084°10'50"W, 0–100 m, 22 Feb 2004 (fr), *Kriebel 4371* (INB); Pital, JOHO Forestal, 10°39'47"N, 084°12'10"W, 85–100 m, 26 May 2004 (fr), *Solano 1092* (INB). **Heredia**. Sarapiquí, La Virgen, Los Arbolitos, Al N de Puerto Viejo, 4 km aguas arriba unión Ríos Toro y Sarapiquí, 10°38'24"N, 084°00'00"W, 20 m, 16 Abr 1993 (fr), *Araya 215* (CR, INB, MO); Puerto Viejo, Estación Biológica La Selva.Finca La Selva the OTS Field Station on the río Puerto Viejo, just E of its junction with the río Sarapiquí, Far loop 1200 m S, 100 m, 08 Jun 1981 (fl), *Hammel 10838* (CR, MO); Estación Biológica La Selva, Finca La Selva the OTS Field Station on the río Puerto Viejo, just E of its junction with the río Sarapiquí, Far loop Trail, 1000 m line, 100 m, 30 May 1980 (fl), *Hammel 8884* (CR, MO); Estación Biológica La Selva, Finca La Selva the OTS Field Station on the Río Puerto Viejo, just E of its junction with the Río Sarapiquí, in forest on ridge 50 m E of junction of Far loop and central trail, 100 m, 13 Jun 1982 (fl), *Hammel 12854* (CR); Estación Biológica La Selva, Flora de la Selva, 11 May 1983 (fl), *Chacón 758* (CR, MO); Estación Biológica La Selva, Original Forest near Río Puerto Viejo, about 2 km up stream from the confluence with Río Sarapiquí, formerly Finca "La Selva" of L.R. Holdridge, 100 m, 14 Jun 1968 (fr), *Barbour 5861* (CR); La Selva Biological Station, 100 m, 25 Ago 1981 (fr), *Smith 88* (MO); finca La Selva, right behind field station, 10°26'N, 084°01'W, 24 May 1971 (fl), *Hartshorn 1028* (MO); entre El Tigre y Las Horguetas, 125 m, 21 Set 1966 (bot. fl), *Jiménez 4135* (MO). **Limón**. La Aurora, Guácimo, ca. 5 km al E del pueblo, sobre el Río Sierpe, frente al puesto del Parque Nacional Tortuguero, 10°24'N, 083°33'W, 100 m, 14 Ago 1988 (fr), *Robles et al. 2048* (CR, F, GH, INB, MO); Pococí, Colorado, southwestern-most ridge of Cerro Coronel NW-facing slope, just S of the Rio Colorado, 10°40'30"N, 083°39'30"W, 10–80 m, 17–18 Set 1986 (bot. fl), *Davidse & Herrera 31384* (INB, MO); Cerro Coronel, E of Laguna Danto, 10°41'N, 083°38'W, 20–170 m, 15–20 Set 1986 (fl), *Stevens & Montiel 24630* (MO); Cerro Coronel, E of Laguna Danto, 10°41'N, 083°38'W, 20–100 m, 16 Mar 1987 (est), *Stevens 24907* (MO). **Puntarenas.** Golfito, Refugio de Vida Silvestre Donald Peter Hayes, Serranías de Golfito, camino a las torres, 08°39'15"N, 83°10'05"W, 400 m, 14 Jun 2000 (fr), *Acosta et al. 1814* (INB, MO); Golfito, Jiménez, Río Tigre, Jardín Botánico El Tigre, 08°30'36"N, 083°24'00"W, 100 m, 03 Set 1996 (fr), *Aguilar 4727* (INB); Osa, Sierpe, Los Mogos, Bahía Chal, 08°43'12"N, 083°26'24"W, 20 m, 03 Ene 1994 (fr), *Aguilar 2934* (INB, MO); Reserva Forestal Golfo Dulce, Mogos, entrada a finca Estrella, Punta Estrella, 08°43'18"N, 083°25'49"W, 138 m, 29 Mar 2002 (fr), *Aguilar 6926* (INB); Reserva Forestal Golfo Dulce, Península de Osa, Los Mogos-Bahía Chal, Finca El Edén, 08°43'57"N, 083°27'09"W, 174 m, 31 Jul 2013, *Aguilar et al. 14529* (INB); Reserva Forestal Dulce, Península de Osa, entrada a Chocuaco, Los Mogos, 08°43'45"N, 083°27'22"W, 100 m, 03 Set 1997 (est), *Salas 372* (INB, MO); Aguabuena, 3.5 km W of Rincón, 4-hectare permanent sample plot 1 km N of BOSCOSA station, 08°43'N, 083°31'W, 350 m, 15 Ene 1993 (fl), *Thomsen 464* (INB, MO). **San José**. Puriscal, Chires, Parque Nacional La Cangreja, Santa Rosa, 400 m, 04 Feb 1973, *Poveda 477*

(CR). **PANAMÁ. Colón.** East ridge, 23 Feb 1968 (fl), *Duke 15268* (MO); Santa Rita ridge, 01 Mar 1971 (est), *Croat 13909* (MO). **Panamá.** Canal Area. River Road near Congo Bridge, NW part of Canal Zone (area west of Limon Bay, Gatun Locks and Gatun Lake), 03 Ago 1955 (fr), *Johnston 1527* (A, MO); Canal Area, northwestern part of Canal Zone (area W of Limon Bay, Gatun Locks and Gatun Lake), 05 Abr 1956 (fl), *Johnston 1791* (A, MO); Barro Colorado Island, 1968 (est), *Knight 1301* (MO); Barro Colorado Island, 04 Feb 1989 (fr), *Garwood 2801A* (MO); San Blas, Cangandí, 09°26'N, 079°07'W, 30 m, 10 Feb 1986 (est), *de Nevers & Herrera 7185* (MO).

4. LAETIA THAMNIA L., Pl. Jamaic. Pug. 31. 1759. Figura 6.

Esta especie se distingue por sus láminas foliares con la base aguda, obtusa o truncada y algunas veces asimétrica, el margen siempre crenado o ligeramente aserrado y generalmente con puntos o líneas pelúcidas; sus inflorescencias principalmente axilares (aunque también supra-axilares o terminales), en cimas corimbosas, con el pedúnculo de 0.5–2.5 (–3.1) cm de longitud; sus botones florales glabros, esparcidamente pubescentes o densamente pubescentes sobre la superficie externa de los sépalos exteriores, y flores con los sépalos entre 3.0–12 × 2.0–7.3 mm; y los filamentos y ovarios pubescentes; y sus frutos globosos, densamente ferrugíneo-tomentosos, con los sépalos rápidamente caducos, y con numerosas semillas cubiertas por un arilo rojo, anaranjado o morado.

El concepto de *Laetia thamnia* aquí entendido y adoptado es de una especie con morfología variable en cuanto al tamaño, forma, ápice y margen de las láminas foliares (Fig. 7). También hay variación en el largo de los pedúnculos y tamaño de los sépalos y frutos. En base a todo el material de *L. thamnia* estudiado (ver colecciones examinadas abajo), ésta se podría separar en dos grupos no muy bien definidos: 1). Un primer grupo lo conforma el material costarricense, proveniente casi exclusivamente de la Cordillera de Guanacaste, a excepción de dos colecciones de Buenos Aires, Puntarenas (*Alfaro 3129* y *Hammel 18274*, INB); más el material de Nicaragua (*Vincelli 313A,* MO, del Departamento Atlántico Norte) y algunas colecciones de Panamá (p. ej., *Aguilar 210*, MO), que se caracterizan por tener hojas un poco más pequeñas, entre 4.9–10.2 × 1.6–3.0 (–3.5) cm, con los márgenes en general notablemente dentados (con 16–30 dientes) y flores con los sépalos de 3.0–5.0 × 2.0–4.0 mm, los exteriores glabros o muy esparcidamente pubescentes sobre la superficie externa. Todo el material del primer grupo, según nuestro estudio, es el que mejor concuerda (aunque no satisfactoriamente) con el material tipo de Jamaica. 2). El segundo grupo corresponde al material de México, Belice y Guatemala, donde algunas colecciones (p. ej., *Aguilar & Chancayun 7155*, MO; *Álvarez 8786,* MO; *Martínez 18325,* MO; *Whitefoord 9533*, MO) llegan a tener láminas foliares similares a las del primer grupo, pero con los sépalos más grandes. En general, este segundo grupo tiene hojas más grandes, entre 6.5–15.3 × 3.6–4.7 cm, con los márgenes crenados o subenteros, y flores con los sépalos de 8.0–12 × 5.0–7.3 mm, por lo general densamente pubescentes (aunque algunas muestras los llegan a tener glabros). Algunos especímenes de la Zona del Canal, Panamá (p. ej., *Croat 4982, 5593*, MO; *Johnston 1716*, A, MO), se asemejan a este grupo.

La variación de *Laetia thamnia* se podría atribuir a su extenso ámbito de distribución en la región mesoamericana. Pero, sin duda, se requieren más estudios exhaustivos de campo y de laboratorio que involucren herramientas moleculares para lograr entender y resolver mejor esta variación. Es probable que bajo el concepto de *L. thamnia* aquí interpretado otra entidad podría estar involucrada.

Distribución. México (Campeche, Chiapas, Quitana Roo, Tabasco y Yucatán), entre los (10–) 20–375 (–746) m de elevación; Guatemala (Izabal, Petén), entre los 50–160 m de elevación; Belice (Belice, Corozal, Cayo, Orange Walk y Toledo), entre (0–) 30– 600 (–750) m de elevación; Nicaragua (Atlántico Norte), entre los 140–260 m de elevación; Costa Rica (Guanacaste y Puntarenas), entre los (100–) 200–850 (–1260) m de elevación; y Panamá (Colón, Panamá y

Veraguas), entre los 30–100 m de elevación; también en las Antillas. Esta especie ha sido reportada para Honduras por Nelson (2008).

Fenología. En México colecciones con flores han sido hechas de marzo a junio y setiembre; frutos de mayo a octubre. En Guatemala las flores han sido recolectadas de marzo a mayo y diciembre; frutos de mayo a julio y diciembre. En Belice flores han sido recolectadas de enero a junio y agosto; frutos de mayo a octubre. En Nicaragua conocida solo en botones florales recolectados en mayo y marzo. En Costa Rica las flores se han recolectado en enero, febrero, mayo, junio y agosto; frutos en febrero, abril y de junio a setiembre. Y en Panamá las flores han sido recolectadas en enero, y de marzo a julio; frutos en marzo, abril y de junio a setiembre.

Nombre común. Chauché, Ixiim Che, Zapote amarillo (México); Bakelac, Hueso de tortuga, Ixbakelac (Guatemala); Bullyhob, Night perfume, Perfume de la noche (Belice); Cafecillo, Quitacalzón (Costa Rica); Conejo, Conejo colorado, Palo blanco, Sarguia (Panamá).

Usos o historia natural. En el Área de Conservación Guanacaste (ACG), Costa Rica, las larvas de las mariposas *Syllepte amando* (Crambidae) y *Cerura rarata* (Notodontidae) se alimentan de las hojas de *Laetia thamnia* (Janzen & Hallwachs 2009). En Panamá, los indígenas Bayano Cuna le atribuyen propiedades medicinales. La madera se recomienda para construcción en general, postes de cerca debidamente tratados y confección de artículos pequeños torneados (Carpio Malavassi, 2003).

Iconografía. Condit et al. (2011: 423).

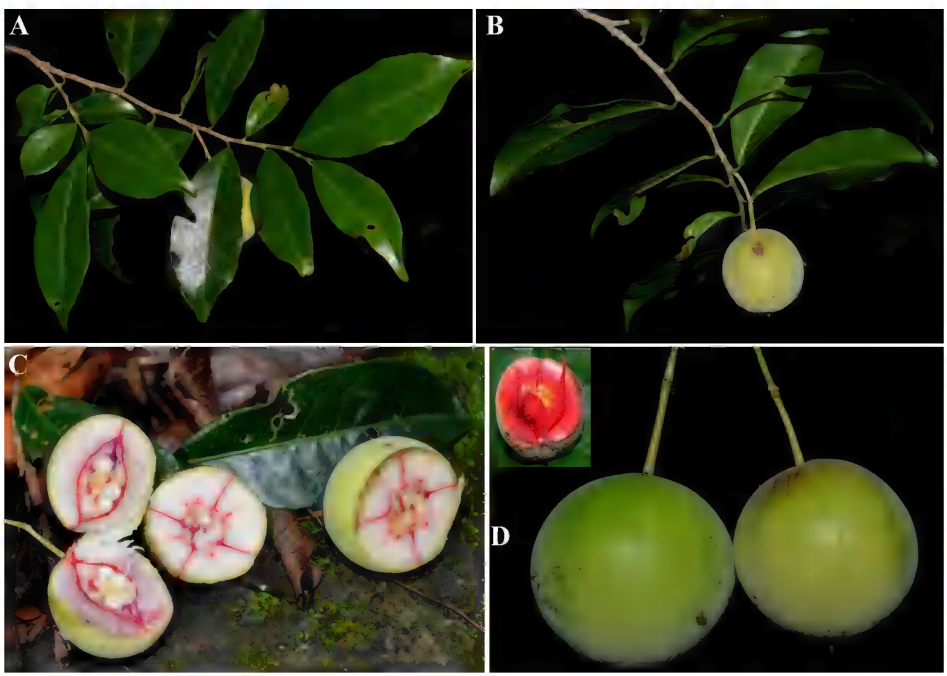

Figura 6. *Laetia thamnia*. **A.** Ramita. **B.** Ramita con fruto. **C.** Cortes (transversal y longitudinal) de los frutos, mostrando el color interno cuando frescos. **D.** Frutos, forma y color; y recuadro, mostrando el color interno después de minutos de ser abierto. (**A–D,** de *Zamora et al. 7063*, INB). Fotos por L. Gao.

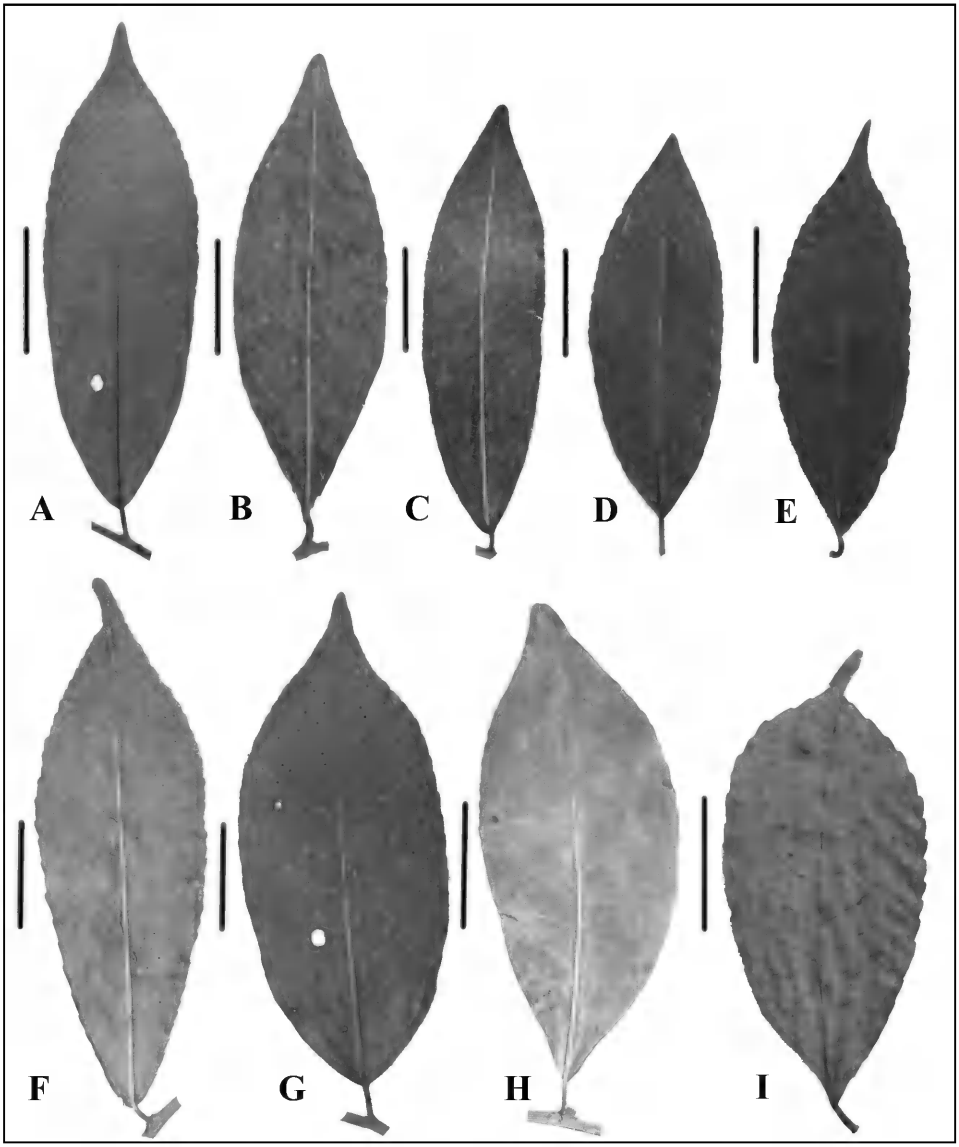

Figura 7. *Laetia thamnia*. Variación en la forma, tamaño, base, ápice y margen de las láminas foliares. **A.** *Whitefoord 3106,* MO (Belice, Belice). **B.** *Aguilar & C. Chancayun 6605*, MO (México, Chiapas). **C.** *Álvarez & Chambor 4866*, MO (México, Chiapas). **D**. *Arvigo & Shropshire 233*, MO (Belice, Cayo). **E.** *Croat 13977,* MO (Panamá, Panamá). **F.** *Vincelli,* MO (Nicaragua, Atlántico Norte). **G.** *Cabrera C. & de Cabrera 4863*, MO (México, Quintana Roo. **H.** *Atha 1009*, MO (Belice, Cayo). **I.** *Ibañez et al. 4831,* MO (Panamá, Veraguas). Escalas= 2 cm.

Especímenes examinados. MÉXICO. **Campeche.** Municipio Calakmul, 6 km al O de Flores Magón, 18°49'00"N, 089°13'23"W, 16 m, 01 May 2002 (fl), *Calónico et al. 23027* (MO); Calakmul. Loc, 13 km al S de Ley de Fomento Agropecuario, camino a Rancheria El Sacrificio,

17°59'N, 089°23'W, 150 m, 21 May 1997 (fr. inm), *Martinez 27311* (MO); 3 km al NE de Narciso Mendoza, 18°15'00"N, 089°26'20"W, 250 m, 13 Mar 1998 (bot. fl), *Martinez et. al 30347* (MO); 500 m E de la Aguado Los Changos, 11 km al NE de Narciso Mendoza, camino a Manatial, Ejido 20 de Noviembre, 18°16'58"N, 089°24'22"W, 260 m, 04 Abr 1998 (est), *Martinez et. al 30516-A* (MO); 3 Km al N de Bel-Ha, camino a Xcan-ha, 18°59'10"N, 089°18'32"W, 100 m, 09 Abr 1998 (est), *E. Martinez et. al 30574* (MO); 6.6 km al O del Poblado Eugenio Echeverria Castello, 18°21'34"N, 089°29'33"W, 293 m, 09 Jun 2003 (fr), *Álvarez 5299* (MO); 1.1 km al NO del poblado 16 de Septiembre, 08°01'21"N, 089°16'42"W, 162 m, 31 Jul 2003 (fr), *Álvarez 6056* (MO); 1 km al E de Conhuás, camino al la Zona Arqueológica Nadzcaan, 18°32'37"N, 089°54'46"W, 204 m, 04 Oct 2002 (fr), *Álvarez 6458* (MO); Municipio Hopelchén, 1 km al S de Scan-ha, camino a Xpujil, 19°05'40"N, 089°19'54"W, 80 m, 29 Jun 1997 (fr. inm), *Martinez & Álvarez 27489* (MO); 12 km al E de Conhuas, sobre la carretera, Chetumal-Francisco Escárcega, 01 Ago 1984 (fr. inm), *Cabrera C. & de Cabrera 6998* (MO). **Chiapas**. Municipio Ocosingo, 5 km al SE de Crucero Corozal, camino a Boca Lacantum, 250 m, 21 Abr 1985 (fl), *Martinez 12180* (GH, MO); en Zona Marqués de comillas, 3 km al SE de Ejido Benemerito de las Américas, camino a Flor de Cacao, 220 m, 13 Ago 1983 (fr), *Martinez 7110* (MO); en el Vértice del río Chixoy, 100 km al S de Boca Lacantum, camino a Chajul, en Zona Marqués de comillas, 120 m, 11 Abr 1985 (bot. fl. y fl), *Martinez 11949* (MO); 40 km al S de Campamento COFOLASA, el cual está a 16 km al NE de Boca Lacantum camino a Palenque, 120 m, 15 Abr 1985 (bot. fl. y fr. inm), *Martinez 12006* (MO); en Crucero Corozal sobre el camino Palenque-Boca Lacantum, 180 m, 18 Abr 1985 (fl), *Martinez 12083* (MO); 5 km al S de Crucero Corozal. Selva alta perennifolia, 250 m, 21 Abr 1985 (fr), *Martinez 12197* (MO); 5 km al S de Crucero Corozal, 250 m, 21 Abr 1985 (fr), *Martinez 12213* (MO); 4 km al S de Frontera Corozal, sobre el río Usumacinta, 120 m, 29 May 1985 (fr), *Martinez 12356* (MO-2 cartulinas); a 27 km al W del Vértice del Río Chixoy, camino a Chajul, 150 m, 10 Set 1985 (fl), *Martinez 13604* (MO); en el Vértice del Río Chixoy a 90 km. al S. de Boca Lacantum, camino a Chajul, 120 m, 17 Abr 1986 (fl), *Martinez 18325* (MO); 1.5 km al S de San Javier, 16°47'10"N, 091°06'14"W, 397 m, 26 Abr 2003 (bot. fl), *Aguilar & Chancayun 6605* (MO); 1.5 km al SE de Nuevo Francisco León, 17°01'06"N, 091°19'08"W, 165 m, 10 Jun 2003 (bot. fl), *Aguilar 7079* (MO); 6.2 km al NO del crucero San Javier, 16°56'24"N, 091°08'44"W, 375 m, 20 Jun 2003 (fl), *Aguilar & Chancayun 7155* (MO); 5 km al S del Crucero San Javier, 16°47'09"N, 091°06'16"W, 360 m, 25 Jun 2003 (fr), *Aguilar 7236* (MO); zona arqueológica de Yaxchilán, 16°53'53"N, 090°57'52"W, 130 m, 28 Ago 1998 (fr), *Rincón 1039* (MO); 6.2 km al NO del crucero San Javier, 16°56'24"N, 091°08'44"W, 375 m, 20 Jun 2003 (bot. fl), *Calónico & Chambor 25189* (MO); 6 km al NO del crucero de San Javier, 16°50'21"N, 091°08'39"W, 360 m, 14 Abr 2003 (fl), *Álvarez & Chambor 4722* (MO); 8.5 km al S de la comunidad Lacanjá Chansayab, 16°41'25"N, 091°05'59"W, 280 m, 20 Abr 2003 (fr. inm), *Álvarez & Chambor 4866* (MO); 1.4 km al E de Crucero Corozal, 16°48'13"N, 091°05'56"W, 500 m, 25 Abr 2003 (fr. inm), *Álvarez & Chambor 4934* (MO); 2–3 km al SE de la Colonia Benito Juárez Miramar, 358 m, 21 Ago 1993 (fr), *Reyes-García & Sousa 2110* (MO); Municipio Ocozocoautla de Espinosa, Selva del Ocote, 32 km NW of Ocozocoautla, 600 m, 27 Ago 1972 (fr), *Breedlove 27504* (MO); Cerro de Palenque, 14 Jul 1939 (fr), *Matuda 3715* (A, MO); Municipio de Ocozocoautla de Espinosa, Ocozocoautla Ejido Emilio Rabasa, caseta de control de la Reserva Selva El Ocote, Sendero el Derrumbadero, 16°54'32"N, 093°36'38"W, 746 m, 29 Abr 2009 (fr), *Gómez HGD 2010* (MO). **Quitana Roo**. Municipio Adolfo de la Huerta, 2.7 al E del poblado San Carlos, 09 Set 2004 (fr), *Álvarez et al. 10596* (MO); Municipio de Benito Juárez, 4 km al N de Puerto Morelos, 03 Jun 1980 (bot. fl. y fr. inm), *Téllez et al. 2568* (MO); 4 km al N de Puerto Morelos, 17 Ago 1980 (fr), *Téllez & Cabrera 3248* (MO); Municipio Carrillo Puerto, 32 km al SO de Felipe Carrillo Puerto, sobre el camino a Kopchen y la Mistekilla, 16 May 1985 (bot. fl), *Cabrera C. & de Cabrera 8312* (MO); Tixcacal, Guardia, 19°51'25"N, 088°10'30"W, 30 m, 26 May 1985 (fr. inm), *Ucán 4081* (MO); Municipio Felipe Carrillo Puerto, Camino a Chan Cah Veracruz, 19°07'48"N, 088°00'36"W, 20 m, 14 Ago 1984 (fr), *Ucán 3462* (MO); 33 km al NE de Cobá, 12 May 1980 (fl), *Téllez & Cabrera 2264* (MO); 13.5 km al E de Señor, 19°52'32"N, 088°00'42"W, 30 m, 04 Mar 2002 (bot. fl), *Calónico &*

Martínez 22388 (MO); 14.2 km al E de Señor, 19°51'33"N, 088°00'01"W, 51 m, 05 Mar 2002 (bot. fl), *Calónico & Martínez 22462* (MO); Municipio Othón P. Blanco, 2 km al NE de Lázaro Cárdenas, vía corta Chetumal-Mérida, 4.5 km al W de la desviación a José María Morelos, por la carretera Chetumal-Carrillo Puerto, 18°59'16"N, 088°11'39"W, 12 m, 02 Ago 2006 (fr), *Tapia et al. 1916* (MO); 5 km al NO del Ingenio Alvaro Obregón (por carretera a la Unión), 10 Abr 1980 (fl), *Téllez & Cabrera 1950* (MO); Municipio Felipe Carrillo Puerto, 12 km al NE de F. Carrillo Puerto, 11 May 1980 (fl), *Téllez & Cabrera 2250* (MO); 16 km al S del Ejido Laguna OM, sobre camino a Tomás Garrido, 06 Jul 1980 (fr), *Téllez & Cabrera 2719* (MO-3 cartulinas); 6 km al N de Xel-Ha, 16 Ago 1980 (fr), *Téllez & Cabrera 3244* (MO); 28 km al S de Botes, sobre la carretera a La Unión, 07 May 1982 (bot. fl. y fr), *Cabrera et al. 2610* (MO); 8 km al NO de Estero Franco, sobre la carretera Chetumal-La Union, 04 Jul 1984 (fr. imn), *Cabrera C. & de Cabrera 6641* (MO); Ejido Caobitas, zona de los pinos, Othon P. Blanco, 18°18'00"N, 089°07'00"W, 120 m, 02 May 1984 (bot. fl), *Chan 3572* (MO); 1.35 km al NO de Jesús Martínez Roos, camino a JoxTum, 19°14'07"N, 088°44'03"W, 97 m, 30 Abr 2004 (fl), *Álvarez 8786* (MO); 5 km al SSO de Gavilanes, 19°27'12"N, 088°46'57"W, 105 m, 21 Jun 2004 (fr), *Álvarez et al. 9576* (MO); Coba, Jun–Jul 1938 (fr), *Lundell & Lundell 7721* (A); 1 km al E de Chanca Veracruz, al sureste de Felipe Carrillo Puerto, 12 Jun 1983 (fl), *Cabrera & Cabrera 4959* (MO); 66 km al S de Ucum, o 22 km al N de la Unión, 14 Jul 1983 (fr), *Cabrera C. 5185* (MO); 5 km al S de Akumal, sobre la carretera Cancún-Tulum, 24 Set 1983 (fr. inm), *Cabrera C. & de Cabrera 5556* (MO); 5 km al O de Centro Vallarta, sobre el camino a Leona Vicario, 16 Jun 1984 (fr. inm), *Cabrera C. & de Cabrera 6417* (MO); en brecha, 4 km al SO del Campo Experimental Forestal San Felipe Bacalar, 28 Jul 1982 (fr), *Cabrera C. & de Cabrera 3239* (MO-2 cartulinas); en brecha a 2 km al N de Estero Franco, por la carretera Ucum-La Unión, 08 Jun 1983 (fr), *Cabrera C. & de Cabrera 4863* (MO); Cozumel, sur de Cozumel, rumbo al Cedral, 20°23'N, 086°55'W, 29 Ago 1985 (fr. inm), *Ortiz 924* (MO); Vallarta, ca. 17 km W of Puerto Morelos, 05 May 1982 (fl), *Davidse et al. 20082* (MO). **Tabasco**. San Isidro. Balacan, 07–11 Jun 1939 (fl), *Matuda 3345* (A, MO). **Yucatán**. Municipio Chemax, Punta Laguna, 12.5 km al N de Cobá, 20°38'45"N, 087°37'53"W, 20 m, 07 May 2004 (est), *Duno de Stefano et al. 1950* (MO); Municipio Temozón, Carretera Temozón-Valladolid, aprox. a 6 km, 20°44'55"N, 088°12'05"W, 08 Ago 1991 (fr), *Méndez & Simá 252* (MO); Municipio Tizimín, 5.5. km al E de la población de Moctezuma, 13 km antes de El Cuyo, por la carretera Colonia Yucatán-El Cuyo, 21°26'19"N, 087°41'21"W, 10 m, 19 May 2006 (bot. fl), *Tapia et al. 1847* (MO); 21 ??? 1917 (fl), *Gaumer 24084* (GH, MO); 1917–1921, *Gaumer 24313* (GH, MO); Chicen Itza, Jun–Jul 1938 (fl), *Lundell & Lundell 7721* (A). **GUATEMALA. Izabal**. La Mina de Exmibal, al E del Estor, 15°31'N, 089°23'W, 50 m, 17 Jul 1988 (fr), *Tenorio et al. 14595* (MO); Puerto Méndez-Cadenas, 12 km on Río Dulce road, 01 Jun 1970 (fr), *Contreras 9931* (MO). **Petén**. La Libertad, 31 May 1933 (fl), *Lundell 3532* (A); La Libertad, 23 May 1933 (fl), *Lundell 3353* (GH); Fallabón-Yaxharoad, Jun 1933 (fr), *Lundell 3952* (A); ca. 5 mi S of Tikal National Park, 19 Jun 1973 (fr) *Dwyer 11261* (GH, MO); Tikal National Park, on Remate road S of Tikal, 03 Jul 1959 (fr), *Lundell 16138* (GH); Uaxactún, 24 Abr 1931 (fl), *Bartlett 12707* (A); Tikal National Park, 24 Jul 1959 (fr), *Contreras 23* (GH); Lake Petén Itza, Santa Elena, on El Jobo, 13 May 1966 (fl), *Contreras 5754* (GH); Macanche, 21 May 1966 (fr), *Contreras 5830* (GH); Laguna Petexbatúm (Laguna México), S of Sayaxché, 50 m, 03 May 1942 (fl), *Steyermark 46218* (A, MO); La Libertad, 15 Jun 1934 (fr), *Aguilar 284* (A, MO); Carmelita, 29 Mar 1964 (fl), *Aguilar 72* [colección mezclada] (MO); Nordwestliche Umgebung des LAgo Petén Itzá: Wald am Abhangzum Arroyo Secco NE-E bei der Lokalität "La Providencia" (= "La Trinidad"), das istca. 3 km NNE-NE San José, 17°01'17"N, 089°52'50"W, 120–140 m, 17 Ago 1993 (fr), *Wallnöfer et al. 5939* (MO); nordwestliche Umgebung des LAgo Petén Itzá: mehr oder weniger naturnaher Wald S des "Bio-Itzá"-Wald-Reservates (Grösse: 6 x 6 km; grenztsüdlichan die Reserva Biósfera Maya undöstlich am Biotopo El Zotz-San Miguel-La Pelotada an und befindet sichim NE-Eck der Gemeinde San José, das istca. 9 km N-NNE San José, 17°08'09"N, 089°56'09"W, 160 m, 26 Ago 1993 (fr), *Wallnöfer et al. 6041* (MO); NW-Ufer des Lago Petén Itzá, Wald-Reste und Sekundär-Waldca, 0.3 km N Zentrum von San José, 16°59'30"N, 089°53'00"W, 12 Dic 1994 (bot. fl. y fr), *Wallnöfer & Tut-Tesucum 9692*

(MO); NW-Ufer des Lago Petén Itzá: anthropogenge störte Seeufer-Vegetationim Bereichzwischen Nuevo San José und der Lokalität "La Providencia" (= "La Trinidad"), das istca. 1–2 km NNE-NE Zentrum von San José, 120 m, 03 Dic 1994 (fl), *Wallnöfer et al. 9599* (MO); Reserva campesina Bio-Itza de San José, 20 Jun 1996 (fr), *Ucán et al. 9161* (MO). **BELICE**. **Belice**. Maskall, 31 Mar 1934 (fl), *Gentle 1201* (A, GH, MO); Maskall, 19 Jul 1934 (fr), *Gentle 1264* (A, GH, MO); Western Highway near Belmopan, 03 Jun 1981 (fl), *Whitefoord 3106* (MO); Western Highway, mile 31, 06 May 1981 (fl), *Whitefoord 2762* (MO); Colonel English Creek, downstream from the Western Highway, mile 31, 16 May 1981 (fr. inm), *Whitefoord 2858* (MO); Northern Highway, ca. Mile 32, road to Altun Ha, 02 Jun 1974 (fl), *Dwyer 12578* (MO); mile 11.5, Northern Highway; Baumgartner's Ridge Lagoon Plantation, 0–15 m [0–50 feet], 14 Ago 1975 (fl), *Dwyer 13065* (MO); Tikal National Park, Km 6 on Uaxactun road, 07 Abr 1968 (bot. fl), *Contreras 7655* (MO); Dos Lagunas, El Cedro, 04 May 1969 (fl., fr), *Contreras 8465* (MO); La Cumbre, Km 138 of Cadenas Road, 30 Jul 1969 (fr. inm), *Contreras 8800* (MO); Turicentro, bordering Lake El Quexil, 05 Feb 1970 (fl), *Contreras 9604* (MO). **Cayo**. 10 km from San Ignacio, Ix ChelFarm.Panti Trail, 17°06'N, 089°04'W, 14 Set 1992 (fr), *Brown & Cocon 107* (GH); vicinity of Millionario, 550 m [1800 feet], 30 May 1973 (bot. fl), *Gentry 7691* (GH, MO); Mile 35 on Western Highway between Belize and Belmopan, 21 Jun 1973 (fr. inm), *Gentry 8391* (MO); W of Hummingbird Hwy, at a point 7 MI S of its juntion, with Western Hwy, north boundary of Roaring River Est, 100 m, 08 Ago 1970 (fr), *Spellman & Newey 1997* (GH, MO); Valentin Retiro road, jun–Ago 1936 (fr), *Lundell 6309* (GH); Chiquibul, Las Cuevas, 16°43'N, 088°59'W, 540 m, 01 Abr 1996 (fl), *Monro 1437* (MO); Chiquibul Forest Reserve San Pastor Ridge, 16°43'N, 088°59'W, 640 m, 15 Jun 1996 (fr. inm), *Ibáñez Garcia & How A82* (MO); W of Terra Nova Forest Reserve, near Eligio Cocom farm, 13 mi N of Iguana Creek Bridge over the Belize River, entering by Black Man Eddy from the Western Hwy, 17°21'N, 088°55'W, 100 m, 24 May 1996 (fl), *Nee & Romero 46833* (MO); Succotz, bordering Rio Mopan, 17 Oct 1967 (fr), *Contreras 7132* (MO); Rio Frio Caves road, Augustine, Mountain Pine Ridge Forest Reserve, 460 m, 19 May 1989 (fl), *Meave & How 1379* (MO); 5 mi N of centre of Spanish lookout settlement on track to Tembos Camp, 17°18'N, 089°01'W, 76 m [250 feet], *Rose Innes 269* (MO); between Anderson road and 1960 road, 15 km SE of Augustine, Mountain Pine Ridge Forest Reserve, 500 m, 15 Jul 1988 (fr), *Meave & Howe 1120* (MO); Vaca Plateau, 16°51'N, 089°02'W, 18 May 1989 (fl), *Arvigo & Shropshire 233* (GH, MO); Western Highway Mile 46, in front of sawmill owned by Belize Forest Project, 17°18'N, 088°48'W, 30 Jun 1995 (fr), *Arvigo et al. 979* (MO); El Pilar, 13 km NW of San Ignacio, near Bullet Tree Village, 17°15'N, 089°08'W, 06 Jun 1994 (fr), *Arvigo et al. 832* (MO); 10 km from San Ignacio, Ix Chel Farm, Panti Trail, 17°06'N, 089°04'W, 14 Set 1992 (fr), *Brown & Cocom 107* (MO); near Terra Nova Forest Reserve, ca. 21 km N of Black Man Eddy Village and Belize River, margins of unpaved road near entrance to reserve, 17°21'N, 088°55'W, 100 m, 06 Jul 1995 (fr), *Atha 1009* (MO); Millinario to Las Cuevas road, 450 m, 01 Jun 1995 (fl), *Whitefoord 9533* (MO); Chiquibul Forest Reserve. Union Camp, 500 m, 27 Abr 1998 (fl), *Whitefoord 10363* (MO); Chiquibul Forest Reserve. Las Cuevas watch-tower hill, 625 m, 26 Abr 1998 (fl), *Whitefoord 10361* (MO); Millionario, 28 Jun 1973 (fl), *Dwyer 10798* (MO). **Corozal**. Corozal-Pachacan [Patchchacan] road, 11 Ago 1933 (fr), *Lundell 4831* (A-2 cartulinas, GH, MO). **Orange Walk**. From Mile 50, Northern Highway to New River Toll Bridge, 07 Jun 1974 (fr), *Dwyer 12744* (GH); Honey Camp, Set 1929 (est), *Lundell 345* (A); Rio Bravo Conservation and Management Area, 17°49'N, 089°02'W, 11–30 Oct 1991 (fr), *Brokaw & Schulze 66* (MO); Indian Church, Burnham Hill, 17°45'N, 088°39'W, 21 May 1977 (est), *Arnason & Lambert 17591* (MO); Indian Church, 29 Jun 1976 (est), *Arnason & Lambert 17119* (MO); Rio Bravo Conservation and Management Area, 17°49'N, 089°02'W, 01–02 May 1992 (fl), *Brokaw 329* (MO); along road between Millionario and Grano de Oro, 518 m [1700 feet], 02–03 Jun 1973 (fr), *Croat 23702* (MO); vicinity of old lumber camp at Grano de Oro, 518 m [1700 feet], 02 Jun 1973 (fl), *Croat 23346* (MO); Mile 54, Northern Highway, 25 Ene 1974 (bot. fl), *Dwyer & Liesner 12221* (MO); from Mile 50, Northern Highway to New River Toll Bridge, 07 Jun 1974 (fr), *Dwyer 12744* (MO). **Toledo**. Near Mafridyle Lagoon, 12 May 1952 (fl), *Gentle 7691* (GH); near Condemn branch Pine ridge, 07 Mar 1945 (fl), *Gentle 5257* (GH); Temash river, 30 m [100 feet], 26

Abr 1935 (fl), *Schipp S-706A* (A, GH-2 cartulinas, MO); Eldorado, Punta Gorda, 90 m [300 feet], 15 Set 1932 (fr), *Schipp 1029* (A, GH, MO); in the western Bladen Nature Reserve in the limestone hills just S of the Bladen River, 16°30'N, 088°54'W, 350 m, 10 May 2002 (fr. inm), *Brewer 1174* (MO); Rio Grande, 10 Jul 1944 (fr.inm), *Gentle 4705* (MO); Bolo Camp, upper reach of Golden Stream River, 16 Abr 1944 (fl), *Gentle 4542* (MO); Southern Maya Mountains, Bladen Nature Reserve, mountains 1.7 airline km N of the EkXux archeological site, 16°31'05"N, 088°54'11"W, 450–600 m, 24 May 1996 (fl), *Davidse 36244* (MO); Southwestern Maya Mountains, Columbia River Forest Reserve, Union Camp, 16°23'N, 089°09'W, 700–750 m, 06 Abr 1992 (fl), *Holst 4111* (MO); Maya Mountains, Bladen Nature Reserve, Upper Bladen Branch basin, ridge immediately W of "AC Camp," 16°30'N, 088°55'W, 370 m, 20 May 1996 (est), *Holst & Whittemore 5443* (MO); southwestern Maya Mountains, Columbia River Forest Reserve, ca. 5 km E of Union Camp, 16°23'N, 089°98'W, 750 m, 09 Abr 1992 (fl), *Holst 4529* (MO); Rio Mojo, mouth to 8 miles inland, 28 Jul 1979 (fr), *Dwyer 14851* (MO). **NICARAGUA. Atlántico Norte**. Unnamed cerro 3 km N of Cerro Bakán, 240–260 m, 10 May 1978 (bot. fl), *Vincelli 313A* (MO); Slilma Sía, 14°38'N, 083°56'W, 140 m, 03 Mar 1971 (bot. fl), *Little 25032* (MO). **COSTA RICA. Guanacaste**. La Cruz. Parque Nacional Guanacaste, Sector Martiza, colecta en bosque alrededor de la Estación, 10°57'38"N, 085°29'42"W, 600 m, 02 May 2000 (bot. fl), *Acosta et al. 1118* (INB, MO); Parque Nacional Guanacaste, Estación Maritza, bosques riparios y en regeneración cerca del paso del Río Tempisquito, 10°57'24"N, 085°29'41"W, 570 m, 09 Ago 2006, *Acosta 5168* (INB); Parque Nacional Guanacaste Estación Maritza, 10°57'36"N, 085°29'24"W, 600 m, 23 Jun 1990 (fr), *Blanco 17* (INB, MO); Parque Nacional Guanacaste, Estación Maritza, 10°57'36"N, 85°29'36"W, 600 m, 26 Feb 1992 (fl., fr), *Espinoza 183* (INB, MO); Parque Nacional Guanacaste, Cordillera de Guanacaste. Sector Orosí (antes: Maritza); sendero Casa Frank (Fram), 10°57'36"N, 085°29'24"W, 600 m, 13 Jul 1994 (fr), *González et al. 303* (INB); Santa Elena. Estación Orosí, camino a áreas de Petroglifos, 09°58'12"N, 085°34'48"W, 450 m, 15 Jul 1996 (fr), *Morales 5505* (INB); Estación Maritza, Faldas Volcán Orosí, sendero a Cacao, 10°57'36"N 085°29'24"W, 600 m, 18 Ago 1993 (fr), *Ramírez 51* (INB, MO); Parque Nacional Guanacaste, Hacienda Maritza, Faldas del Volcán Orosí, 500 m, 28 Jul 1986 (fr), *Chacón & Chacón 2072* (CR, MO); Volcán Orosí, Estación Biológica Maritza, sendero Mataredonda, 10°57'N, 085°29'W, 400–500 m, 07 Jun 1996 (fr), *Short et al. 67* (MO); Parque Nacional Guanacaste, Estación Maritza, 10°57'36"N, 085°29'36"W, 600 m, 01 Jul 1989 (fr), *II INBio 73* (MO); Parque Nacional Guanacaste, Estación Maritza, 10°57'36"N, 085°29'36"W, 600 m, 01 Jul 1989 (fr) *I INBIO 86* (MO), Liberia, Mayorga, Estación Cacao, Faldas de Cerro Pedregal, frente a la estación, 10°55'12"N, 085°28'48"W, 700 m, 05 Jun 1990 (fl), *Hammel et al. 17776* (CR, MO); Estación Cacao, Quebrada Pedregal, 10°54'36"N, 085°28'48"W, 700–900 m, 06 Jun 1990 (fl, fr), *Hammel et al. 17797* (INB, MO); Estación Maritza, trail from Maritza to Cerro Cacao, 10°57'N, 085°29'W, 600 m, 31 Ago 1990 (fr), *Solomon 19106* (INB, MO); Estación Maritza, Sendero Cacao, 10°57'40"N, 85°29'40"W, 600 m, 19 Ago 1993 (fl), *Zamora 2110* (INB, MO); Refugio de Vida Silvestre Laguna Mata Redonda, Parque Nacional Guanacaste, Estación Maritza, Laguna Mata Redonda, con una condición de 95% seca. Sendero de Mata Redonda, 10°19'23"N, 085°25'15"W, 100–450 m, 20 Abr 2008 (fr), *Zamora 4319.1* (INB, MO); Parque Nacional Rincón de la Vieja, Santa María Station, Colibrí and Aguas Termales Trail, 10°45'50"N, 085°18'28"W, 800 m, 04 Jun 2013, *Zamora et al. 6321* (INB); Hacienda Santa María, siguiendo el canal 1 km sobre el mismo, partiendo de la planta Hidroeléctrica, 10°48'N, 085°19'W, 800–850, 09 Ago 1987 (fr), *Herrera 678*(CR, INB); Parque Nacional Rincón de la Vieja, sendero a aguas azufradas, Quebrada Azufrales, aguas arriba, 10°46'10"N, 085°19'00"W, 840 m, 12 Set 1990 (fr), *Rivera 503* (INB, MO); Bagaces. Parque Nacional Rincón de la Vieja, sendero Aguas Termales, 10°46'12"N, 085°17'48"W, 1260 m, 29 Ene 1991 (fl), *Rivera 1033* (INB, MO); Cañas, Cordillera de Tilarán, Faldas sur Este Volcán Tenorio, Nueva Guatemala, parcelas I.D.A, 10°38'24"N, 085°01'12"W, 800 m, 11 Ago 1993 (fl), *Rodríguez et al. 210* (INB). **Puntarenas**. Buenos Aires, Reserva Indígena Boruca-Térraba, Alto Corre Viento de Boruca, Punto 61, 08°58'57"N, 083°17'25"W, 380 m, 08 May 2000 (fl), *Alfaro 3129* (CR, INB, MO); Potrero Grande, Carretera Interamericana Km 217–218, sabanas, potreros secos y quebradas ca. 5 km

N de Paso Real, Finca Murciélago, 09°01'48"N, 083°15'00"W, 200 m, 09 Jul 1991 (fr), *Hammel 18274* (CR, INB, MO). **PANAMÁ. Coclé**. Chorro Las Mozas, El Valle de Antón, 08°37'N, 080°08'W, 560 m, 30 Jul 1997 (fr), *Correa et al. 11480* (MO). **Colón**. Chagres, 05–12 Mar 1850 (fr), *Fendler 106* (MO). **Panamá**. Aroud Alhajuela, Chagres valley, 30–100 m, 12–15 May 1911 (bot. fl), *Pittier 3514* (GH); Barro Colororado Island, 06 Jul 1931 (fr), *Bailey & Bailey 504* (GH); Road to Devils Beach, NW part of Canal Zone, area W of Limon Bay, Gatun Locks and Gatun Lake, 27 Mar 1956 (fl., fr), *Johnston 1716* (A, MO); Barro Colororado Island, 24 Jul 1936 (fl), *Zetek 3687* (MO-2 cartulinas); Barro Colororado Island, 20 Abr 1968 (fl), *Croat 4982* (MO); Barro Colorado Island, N shoreline of Gigante Bay, 08 Mar 1981 (fl), *Croat 13977* (MO); Barro Colorado Island, Pina Blanca Bay, 31 Jul 1934 (fr), *Shattuck 1096* (MO); Barro Colorado Island, 16 Ago 1966 (fr), *Oppenheimer 1131* (MO-2 cartulinas); Barro Colorado Island, Zetek trail, 06 Jul 1931 (est), *Starry 40* (MO); Sherman and Fort San Lorenzo, 10 Jul 1971 (fr), *Croat 15430* (MO); Barro Colorado Island, at Bangs House, 03 Ago 1937 (est), *Zetek 3906* (MO); N edge of large cove on the E side of Burunga Peninsula, 16 May 1968 (fl), *Croat 5593* (MO-2 cartulinas); Barro Colorado Island, 11 Ago 1985 (fr), *Garwood 1457A* (MO); Barro Colorado Island, shoreline, Harvard Peninsula to Chapman Cove, 28 Ago 1985 (fr), *Garwood 1482A* (MO); Barro Colorado Island, 25 Jun 1984 (fl, fr), *Schmalzel x6* (MO); Isla Majé, Bayano, 10 Jun 1977 (fl), *Aguilar 210* (MO); Isla Majé-Bayano, 15 May 1976 (fl), *Aguilar 57* (MO); Piria-Cañasas trail near to Piria (fr), 100 m, 22 Set 1967 (fr), *Duke 14333[4]* (MO-2 cartulinas); Pipeline road 2 mi from Gamboa gate, 08 Ago 1971, *Croat 16611* (MO); along R. Juan Diaz, above Juan Diaz, 30 m, 28 Mar 1985 (fl), *Allen 932* (MO-2 cartulinas); near archeological site at edge of Madden Lake, 09 Abr 1972 (fr), *Gentry 5034* (MO); trail from Río Espavé toward Río Agua Clara, 23 Ene 1972 (fl), *Gentry 3763* (MO); Panamá, (fr), *Duke? 5555* (MO); wood along along Panam Hwy, ca. halfway between El Llano and Rio Mamon, 06–08 Set 1962 (fr), *Duke 5555* (MO). **Veraguas**. Parque Nacional Coiba, Río Negro, 40 m, 19 Mar 2006 (fr), *Ibañez et al. 4831* (MO); Isla Coiba, 28 Jul 1962 (fr), *Dwyer 2389* (MO).

AGRADECIMIENTOS

Damos las gracias a Chris Davidson, Sharon Christoph, finca Caré, y la fundación Blue Moon por su apoyo al Proyecto de las Plantas Vasculares de la Península de Osa, Costa Rica; Juan Mata-Lorenzen y Lian-Ming Gao que facilitaron las imágenes de las figuras 3 y 6, respectivamente; y también, a los herbarios A, CR, F, GH, INB, MO, y PMA por permitir el acceso y estudio de sus colecciones. También agradecemos a Michael. H. Grayum por sus excelentes comentarios y revisión previa de este artículo.

Daniel Santamaría-Aguilar agradece al Missouri Botanical Garden por la beca otorgada "Elizabeth E. Bascom para Botánicas (os) Latinoamericanas (os)"; se agradece a dicha institución por el apoyo económico y a todo el personal y en especialmente a A.L. Arbeláez, R. Abbott. y R. Liesner por todas las facilidades brindadas. También agradece a los curadores y asistentes del herbario de la Universidad de Harvard por su hospitalidad y las facilidades otorgadas.

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Shipunov, A., L. Abramova, J. Beaudoin, J.H. Choi, D. Fry, R. Perry, V. Shipunov, J. Schumaier, and J. Theodore. 2015. Flora of North Dakota project. Phytoneuron 2015-15: 1–10. Published 4 March 2015. ISSN 2153 733X

FLORA OF NORTH DAKOTA PROJECT

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ABSTRACT

In 2011, we started the systematic investigation of the North Dakota flora with a priority of filling "botanical white spots." Most of the state is now covered with sampling of approximately 30 by 30 miles density. More than 3,500 herbarium samples were deposited into Minot State University herbarium collection (MISU). Databasing and digitization started at the time of collection: almost every sample has an associated geo-referenced photograph and permanent herbarium labels have been made from the database. The checklist of North Dakota plants is published both as a Web service and as downloadable PDF book; it is a result of automated conversion of more than 40 species lists, processed with multiple "filters" that add information to species names. Nomenclature problems were solved via programmatic normalization. To date, the known flora of North Dakota consists of 1751 species, 667 genera and 124 families of vascular plants. While proportions of plants common between this state and neighboring territories are equal, species composition reveal that the flora of North Dakota is most similar to the flora of South Dakota.

Almost every state in the USA has created multiple inventories of its plant and animal life. These reviews help to manage natural resources, monitor invasive and dangerous species, identify new useful plants and animals, educate local communities, supply natural gardening, and save rare and endangered species from extinction. North Dakota has never been researched in full for plant diversity: only one book has been published (Stevens 1950); floristic research begun in the 1970s at NDSU was not finished, and by 2010 more than 45% of North Dakota's territory was still awaiting botanical investigation (Fig. 1). From several North Dakota counties, less than 10 herbarium samples had been collected.

Although North Dakota was not under intensive natural history investigation, the state has several unique features. Being treeless and the most flat and wetland-rich part of the Northern Great Plains, it includes a Continental Divide, a region of numerous prairie potholes that are result of delayed glacial melting (Bluemle 2000). The western part of the state was not under glaciation and is therefore more similar to the neighboring territories of Montana (Royer 2003). One of the most remarkable spots is the Devils Lake region, the second self-drainage basin in North America. The wide Red River Valley is the remnant of Great Lake Agassiz (Bluemle 2000). One of the few forested regions is the "glacier garbage" Turtle "Mountains, which contain the only known peatmoss bog in the state (Stevens 1950).

Material and Methods

In 2011, we started the systematic investigation of the state flora with a top priority of filling "botanical white spots" (Fig. 1) and normalizing the sampling level for counties underrepresented in herbarium collections. To date, most of the territory is covered with sampling of approximately 30 by 30 miles density. In 2013-2014, attention was paid to the "hot spots," regions with the richest flora such as Forest River (Grand Forks County) with 504 species of vascular plants. We have collected more than 3500 herbarium samples, which are deposited in Minot State University herbarium

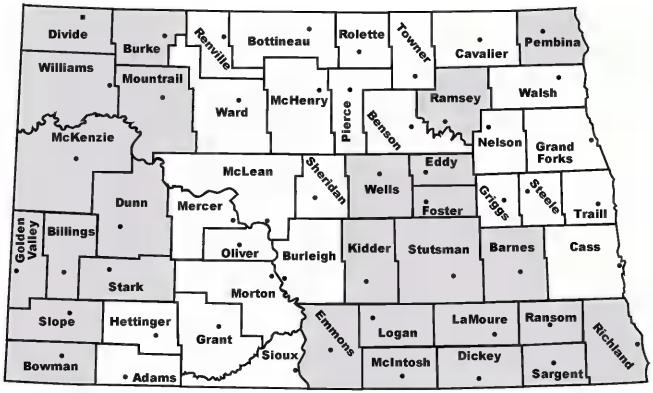

Figure 1. North Dakota counties. Counties not investigated botanically by 2010 (botanical "white spots") are not shaded.

(MISU). As a result, the total size of the collection was doubled (from 3300 samples in 2010 to 7100 in 2015). In addition, the DNA barcoding project for North Dakota flora was started in collaboration with the Barcoding of Life Consortium and now includes sequences from almost 400 species.

Our collection workflow (Fig. 2) has consisted of several steps. First, Google Earth maps, along with North Dakota Fish and Wildlife "PLOT" maps, were used to select the candidate locations, usually non-private land with potentially undisturbed or little disturbed plant communities. Every year, our season started in the end of May and ended in October. Neighboring locations were usually accessed in different months. Since our driving distances were typically large (200–300 miles round trip in average), we frequently spent only 2–4 hours per locality. To optimize the collection process, we photographed every plant before collection (with GPS location recorded in EXIF data of photograph), pre-pressed it, and labeled with temporary labels containing only three numbers: locality, collection and image, and habitat notes. In most locations, we collected all plant species with flowers and/or fruits.

To make the permanent labels and herbarium database, we used the location table and the primary table, which contained the data from temporary labels plus the plant identification. Merging these two tables programmatically updated the MISU herbarium database, which in turn was the source of permanent herbarium labels. Consequently, since labels were created from database entries, the databasing of herbarium was not needed as a separate working task. In addition, as every plant was photographed in the field, herbarium digitization was done on its own.

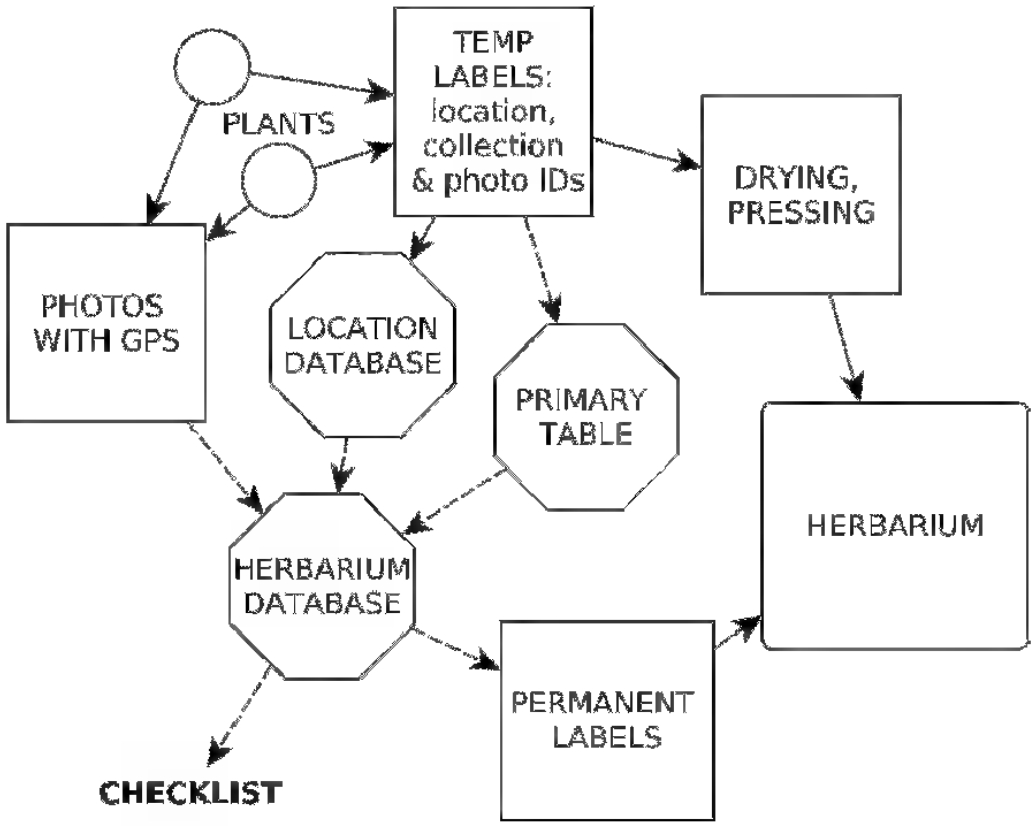

Figure 2. The scheme of our collection workflow. Dashed arrows represent "automatic" steps, performed programmatically.

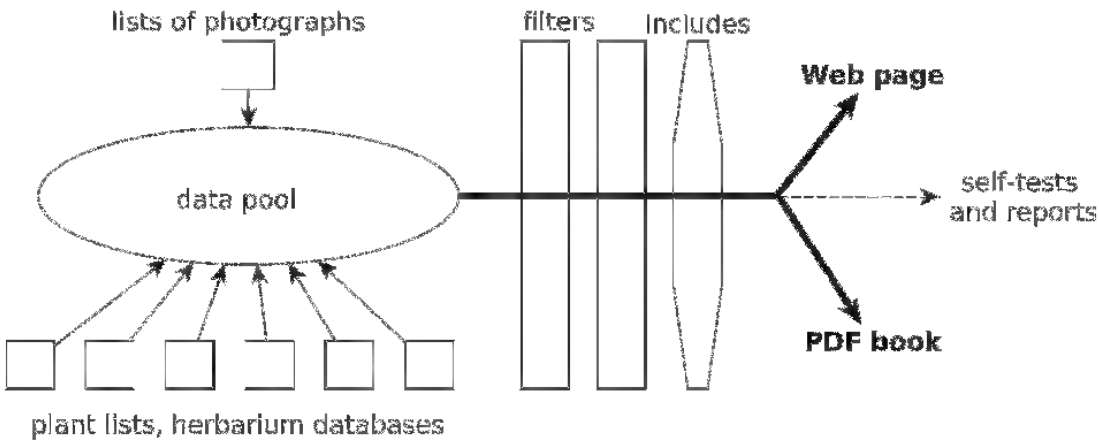

Figure 3. The scheme explaining the creation of the North Dakota checklist. Bold arrows emphasize two main representations of the checklist; the dashed arrow indicates self-testing.

To create the checklist of North Dakota plants, we also used programmatic tools (Fig. 3). All data was initially represented in flat text tables on a local computer and then was programmatically merged into the checklist, simultaneously outputting the HTML Web page and PDF book (located at "Flora of North Dakota: Checklist," Shipunov 2012–onwards; the PDF file is also uploaded to archive.org). This semi-static approach is not based on any existent database system but has employed multiple text tools (Mesibov 2015) and in our case, also an R data processing environment (R Core Team 2014). Authors would be happy to share the code with all interested parties.

The aforementioned "flat text tables" were our sources of information. In all, we used more than 40 different resources, from "classically" published works and Internet databases (Atlas of the flora of Great Plains,1977; Barker et al. 1978; Barlow 1987; Bergman 1918; BISON, 2014; Bry 1986; DeKeyser 1995; Dix & Smeins 1967; EDDMapS 2013; Facey et al. 1986; Godfread 1976; Hansen 2008; Hegstad 1973; Larson 1979; Larson 1993; Lautenschlager 1964; Lunell 1915-1918; Meinke 1991; NatureServe 2013; North Dakota Department of Agriculture 2013; Okerson 2001; Pelvit & Barker 1975; Petrik-Ott 1979; Rohde-Fulton 1985; Seiler 1973; Seiler & Barker 1985; Stevens 1950; Stevens 1966; The Biota of North America Program 2013; USDA noxious weeds 2013; USDA PLANT database 2013; Willenbring 1971; Williams 1979; Zaczkowski 1972) to local off-line electronic resources (the most important were UND and NDSU herbarium databases). An updated list of these resources may be found on the checklist Web site.

Two representations (the Web service and the downloadable PDF book) of the illustrated checklist are constantly updating: when a new name or a new list appears, both the book and Web page are updated simultaneously through scripts written for an R statistical environment and TeX/LaTeX text formatting system. The checklist is the product of interactions between computer scripts and multiple flat text databases. This semi-static Web service could be used for the variety of applications; for example, it was used to check and enhance the second edition of P. Kannowski's book "Wildflowers and Grasses of North Dakota" (2014).

The Web portion of the checklist is based on the DataTables plug-in for jQuery (2015) and therefore is the client-side application. This may be downloaded and used on a local computer without an Internet connection.

One of the key concepts of the checklist is the "filtration." For example, to create the checklist, all species lists are "filtered" through the synonyms table. This table was initially made with the Taxonomic Name Resolution Service (Boyle et al. 2013) and in essence contains two columns: string to replace and the replacement. If the name from the species list is a taxonomic synonym, or simply mistyped, the filtering process replaces it with the accepted one, because the synonyms table contains replacement rules for most occasions. If after the update of source, the new name appears, it will be easy to catch since it will also appear in the self-test output table (Fig. 3). If this new name is incorrect, the checklist maintainer will add a new entry to the synonyms table, and from that time it will be automatically replaced with a correct one. A similar approach was used to add information about families, common names, rarity, invasive status and color of flower to the checklist. In addition, the programmatically-made PDF book contains information from "includes." These arbitrarily-placed pieces of the text could be used to insert keys and morphological descriptions into the main text.

The amount of data collected allowed to make the statistical overview of the flora of North Dakota. This includes total numbers of species, genera, and families, most frequent plant species, top families, and elucidation of geographic affinities of the flora, and comparisons between counties. To compare with neighboring states or provinces, we used USDA PLANT database (2013).

Results

The flora of North Dakota consists of 1751 species, 667 genera, and 124 families of vascular plants (in accordance with Shipunov 1991–onwards). In addition, 240 species are mentioned for the state without location. The flora is dominated by Compositae, Gramineae, Cyperaceae, Leguminosae, and Cruciferae (Fig. 4). A high abundance of Cyperaceae, Amaranthaceae, and Ranunculaceae probably is related to a high coverage of wetlands (Larson 1993). The dominant families are frequent for temperate grass and wetland floras and are typical for Northern Great Plains (Great Plains Flora Association 1977).

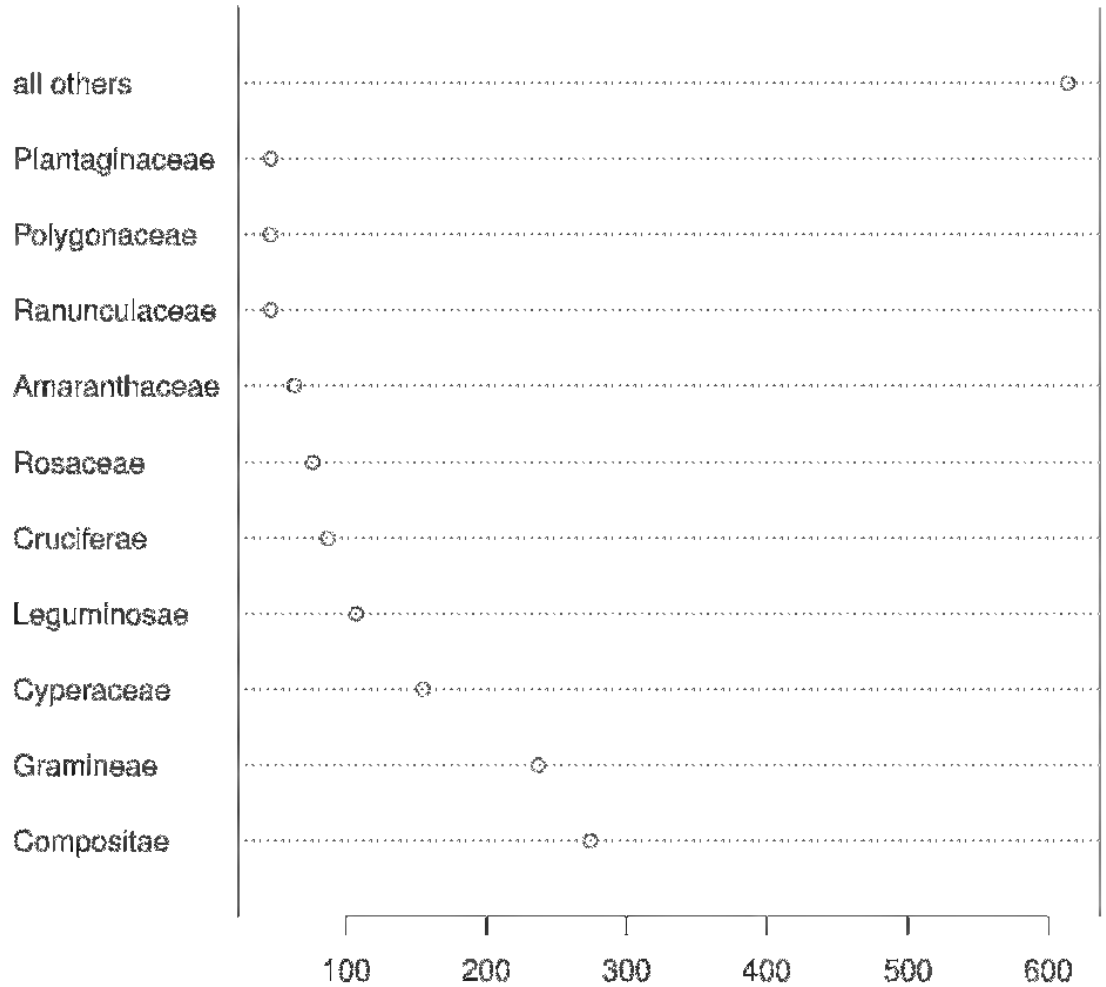

Figure 4. Families of flowering plants dominant in North Dakota.

Using herbarium databases, we found that most frequently collected species were *Polygonum amphibium*, *Sonchus arvensis*, and *Symphyotrichum lanceolatum* (Fig. 5). Among North Dakota counties, Ransom and Richland have the most diverse flora (more than 55% of state species), while Trail, Adams, and Towner have the least diverse flora (less than 25%). North Dakota has 139 "local endemics," e.g., *Trillium erectum, Reseda odorata*, species that do not occur in any neighboring state or province. 37 species were found in all surrounding territories but not in North Dakota (e.g., *Nymphaea odorata*, *Moneses uniflora*).

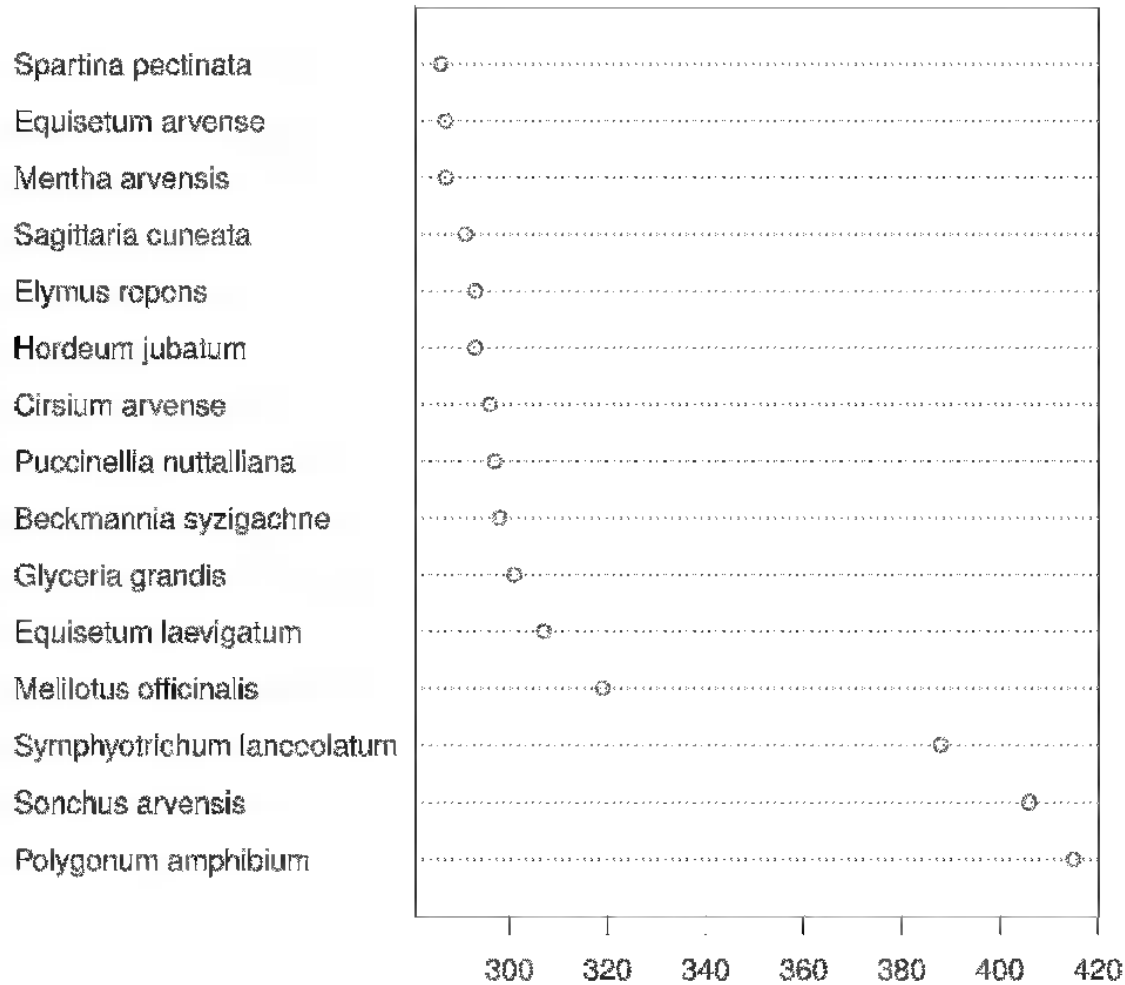

Figure 5. 15 most frequently collected species.

The proportion of plants common between North Dakota with each of the four neighboring regions (Fig. 6) is statistically equal (proportion test χ-squared = 24.35, df =3, $p << 0.05$). The cluster analysis of species composition consistently revealed that our flora is most similar to the flora of South Dakota (Fig. 7). The Montana flora has the significant Rocky Mountains component (evidently absent in North Dakota), whereas floras of Minnesota and Canadian provinces have many sylvan species. However, North Dakota has the biggest number of common unique plants (plants which grow only in two states) with Minnesota (58 species) and then with Montana (40 species), perhaps indicating routes of plant distribution.

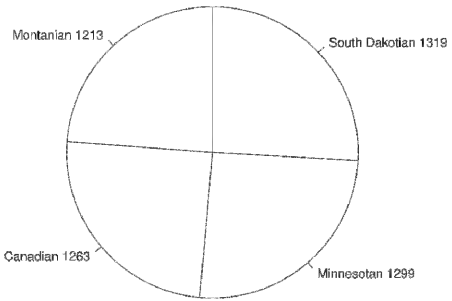

Figure 6. Proportions of plants common between North Dakota and neighboring territories. Numbers on the plot indicate numbers of common species.

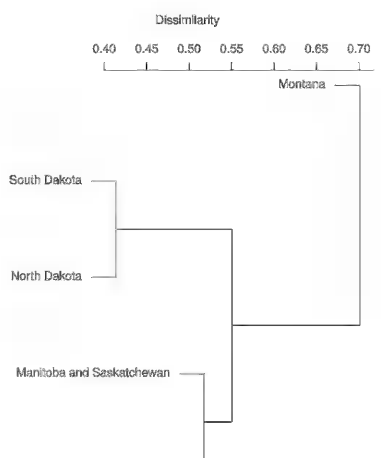

Figure 7. Dendrogram-represented results of the hierarchical cluster analysis (based on Jaccard similarity) of floras.

In 2011–2014, we were able to find 18 species that were never previously mentioned for the North Dakota, including, for example, *Iris germanica* (Pembina Gorge, Cavalier County). In the Lake George environs (McHenry County), we discovered the putatively easternmost location of the *Pinus ponderosa*.

Discussion

The flora of North Dakota project has several unique biodiversity informatics features. First, digitization starts at the time of collection and databasing precedes labeling. Second, the flora checklist is a semi-static Web service based on scripts that "filter" flat tables. Third, the flora manual (downloadable public domain PDF) with associated floristic data is self-growing. We hope that some of these concepts will be useful for other biodiversity projects.

ACKNOWLEDGEMENTS

The project was supported by Great Plains Center for Community Research and Service (GPCCRS) of Minot State University and North Dakota INBRE. We are grateful to so many people, including Shawn DeKeyser (NDSU: NDA Herbarium) and Kathryn Yurkonis (UND: GFND Herbarium) for their invaluable help with collections and Maria Kuzmina (Barcoding of Life Consortium, BoLD Systems) for the assistance with barcoding of North Dakota flora. Multiple organizations like UMT (Bozeman, MT), NDSU (Fargo, ND), and UND (Grand Forks, ND) herbaria, Missouri Plateau database project (BHSU), and U.S. Fish and Wildlife Service (Devils Lake District) provided us with assistance in our project. Taxonomic Name Resolution Service (iPlant Collaborative) provided the excellent internet service that allowed us to efficiently normalize our databases.

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LYSIMACHIA LEWISII (PRIMULACEAE): A NEW SPECIES FROM TENNESSEE AND ALABAMA

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ABSTRACT

Lysimachia lewisii D.Estes, J.T. Shaw, and C. Mausert-Mooney **sp. nov.** (Lewis's yellow loosestrife), a new rare southeastern USA endemic, is described from central Tennessee and northern Alabama, where it is known from just three counties. This species has been confused in the past with *L. tonsa*, *L. hybrida*, and *L. lanceolata* but is probably most closely related to *L. tonsa*, *L. quadriflora*, and *L. radicans*. It grows in dry oak-hickory woodlands on ridges and upper slopes in dry, cherty, acid soils. A key is provided to differentiate this species from the other members of *Lysimachia* subg. *Seleucia* of Alabama and Tennessee.

In the past decade, several new plant species have been described from Tennessee (Wofford 2006; Estes & Small 2007; Estes & Beck 2011; Estes 2012; Estes 2013; Floden 2013; Schilling et al. 2013) and adjacent northern Alabama (Kral 1987; Simmers & Kral 1995; Sorrie et al. 2013). Currently more than a dozen undescribed species await description in Tennessee alone. Some of these discoveries were made while studying herbarium specimens and conducting fieldwork in conjunction with the development of the *Guide to the Vascular Flora of Tennessee* (Tennessee Flora Committee, in press). In this paper, we present one of these new species. The taxonomic affinities, geographic distribution, ecology, and collection history of this species are discussed.

LYSIMACHIA LEWISII D. Estes, J.T. Shaw, & C. Mausert-Mooney, **sp. nov.** TYPE: **Tennessee.** Lewis Co.: Meriwether Lewis National Monument off Natchez Trace Parkway, 9.6 km by air SE of Hohenwald, on hiking trail NE of Old Spring, growing on SE-facing mid-slope in hollow that leads to Little Swan Creek, 31 July 2008, *T. Duke 106 with D. Estes* (holotype: APSC; isotypes: FSU, GA, GH, LSU, MO, NCU, NY, TENN, UARK, US, UWAL, VDB) (Figures 1–2).

Lysimachia lewisii is probably most closely related to *L. tonsa* (Alph. Wood) Alph. Wood ex Pax & R. Knuth, *L. radicans* Hook., and *L. quadriflora* Sims as judged by the nature of the cilia confined to the nodal region at the base of opposing leaf bases. It is distinguished from *L. tonsa* by its narrowly

elliptic-lanceolate, arcuate-recurving leaves, 0.5–1.2 cm wide and 4–9 times longer than wide (vs. in *L. tonsa* the leaves are ovate to ovate-lanceolate, non-arcuate, 15–44 mm wide, and 1.5-4.5 times longer than wide). It differs from *L. radicans* in its erect (vs. decumbent) habit, larger flowers and sepals, and preference for dry upland habitats (vs. swamps). It differs from *L. quadriflora* in its wider leaves and prominent petioles and in its upland habitat (vs. linear leaves that are sessile or subsessile, and calcareous wetland or streambank habitat). It differs from *L. lanceolata* Walter by its longer and more conspicuous ecliate petioles (vs. petioles ciliate throughout and onto proximal leaf blade margin in *L. lanceolata*), taller, more branched habit, larger corollas, and lack of rhizomes. It differs from *L. hybrida* Michx. in that its cilia are confined to the nodal region only instead of extending up the proximal half of the petiole, its leaves tend to be widest at the middle (vs. below the middle), and it occurs in dry uplands (vs. open wet meadows, natural ponds, and swamps).

Erect, rarely reclining, perennial herbs, (22–) 36–73 (–92) cm tall. **Roots** simple, fleshy from a small rootstock; rhizomes lacking. **Stems** initially simple but in age developing few to many spreading-ascending branches distally, with (8–) 9–15 (–18) nodes, 6-angled and more or less rhombic in cross-section, the two opposing faces narrower than the other four, each angle distinctly raised forming a narrow ridge, pale reddish-brown and dotted with numerous pale spots, finely granular-puberulent with reddish glands. **Leaves** simple, opposite, petiolate; **petioles** slender, initially flat but becoming narrowly U-shaped in cross section, finely granular-puberulent with reddish glands, opposing petioles somewhat joined at the node by a narrow hyaline flange of tissue bearing small cilia where petiole bases connect at nodes, those at mid-stem (10–) 12–22 (–25) mm long; **leaf blades** narrowly lanceolate, lance-elliptic, to narrowly oblong, and sometimes slightly falcate, those at the stem base wider and shorter relative to cauline leaves and mostly ovate-lanceolate, cauline leaves often bearing reduced leafy stems in their axils giving the appearance of false-whorls, the blades spreading to ascending, flat to broadly U-shaped in cross-section, and often longitudinally recurved or sickle-shaped, (2–) 4–7 (–9) cm long, (0.5–) 0.7–1 (–1.2) cm wide, (4–) 4.8–8 (–9) times longer than wide, 4–8 veined with the veins alternate, reddish or greenish and slightly impressed adaxially and raised abaxially, sparsely covered with small reddish glands but otherwise smooth, margins entire but with a thickened, finely papillose border, bases broadly cuneate to narrowly rounded, leaf apices acute-acuminate, adaxial surfaces green, abaxial surfaces somewhat paler, both surfaces slightly shiny and sparsely covered with small, red, sessile glands. **Flowers** at first solitary in median and upper leaf axils along the main stem but soon developing at the terminus of distal lateral branches in the axils of reduced leaves; the leafy axillary branches have short internodes giving the appearance of congested cymes, the arrangement of the flowers throughout the distal half of the plant gives the impression of an elongated leafy thryse; **pedicels** slender, ascending, (0.4–) 0.9–2.3 (–3.2) cm long, covered with small red sessile glands; **calyx** 5-lobed, the lobes (4.0–) 5.0–7.0 (–8.0) mm long and (2.0–) 3.0–5.0 (–6.0) mm wide, appearing distinct but actually slightly connate at the base, spreading to slightly reflexed in flower but becoming erect, somewhat campanulate in fruit, lanceolate with acuminate apices, abaxial surfaces concave in fresh material, green, and sparsely covered with red sessile glands, prominently 5-veined with the veins somewhat reddish; **corolla** rotate with 5 bright yellow corolla lobes, (1–) 1.3–2.5 (–3) cm across, the lobes broadly ovate, elliptical, or rarely orbicular, (0.3–) 0.5–0.9 (–1) cm long and (0.3–) 0.4–0.7 (–0.8) cm wide, margins irregularly and somewhat raggedly serrate-dentate, apices acute, round, or truncate into the abruptly short-caudate apex, bases rounded into broad claw-like bases before becoming connate at the very base, veins of corolla lobes numerous and straight, abaxial and adaxial surfaces glandular-puberulent, the base of the adaxial surface of the corolla lobes raised forming a densely glandular and reddish 5-lobed nectary, the apex of each nectary lobe bearing a narrowly ovate staminodium, (0.2–) 0.3–0.7 (–1.0) mm long; **stamens** 5, each alternating with the staminodia and opposite the corolla lobes; **filaments** pale yellowish and glandular, (2–) 2.5–4.6 (–6) mm long; **anthers** 5, basifixed, pale creamy yellow, (3–) 3.2–5.9 (–8) mm long; **pollen** cream to white; **pistil** green, (0.4–) 0.5–0.8 (–1.2) mm long, **ovary** green and glabrous, (0.2–) 0.3–0.6 (–0.9) mm high and (0.1–) 0.1–0.3 (–0.5) mm wide, **style** pale green, (2.0–) 3.0–6.0 (–8.0) mm long, **stigma** scarcely

differentiated from style, 0.1–0.3 (–0.4) mm long. **Capsules** globose, brown at maturity, style withering. **Seeds** 10 per capsule, ovoid, sharply trigonous in cross section, finely honeycomb reticulate, surface reddish-brown, the raised walls of the reticulations whitish, giving the seed a reddish-frosted appearance, 1.5–2.0 mm long and 1.0–1.4 mm wide. **Chromosome number** unknown. **Common Name** Lewis's Yellow Loosestrife.

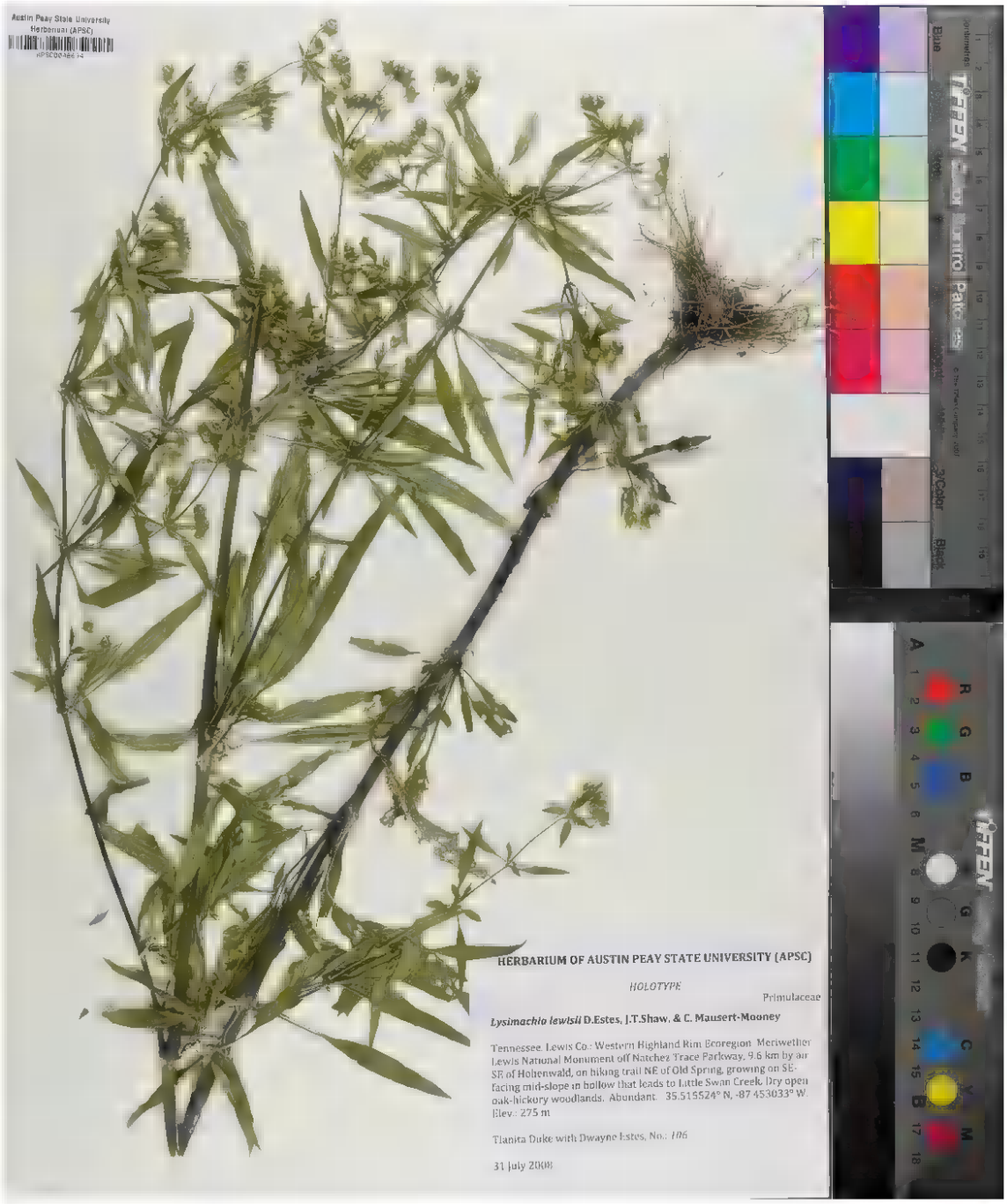
Austin Peay State University
Herbarium (APSC)
HERBARIUM OF AUSTIN PEAY STATE UNIVERSITY (APSC)
HOLOTYPE
Primulaceae
Lysimachia lewisii D.Estes, J.T.Shaw, & C. Mausert-Mooney
Tennessee. Lewis Co.: Western Highland Rim Ecoregion. Meriwether Lewis National Monument off Natchez Trace Parkway, 9.6 km by air SE of Hohenwald, on hiking trail NE of Old Spring, growing on SE-facing mid-slope in hollow that leads to Little Swan Creek. Dry open oak-hickory woodlands. Abundant. 35.515524° N, -87.453033° W. Elev.: 275 m
Tlanita Duke with Dwayne Estes, No.: 106
31 July 2008

Figure 1. Holotype of *Lysimachia lewisii*.

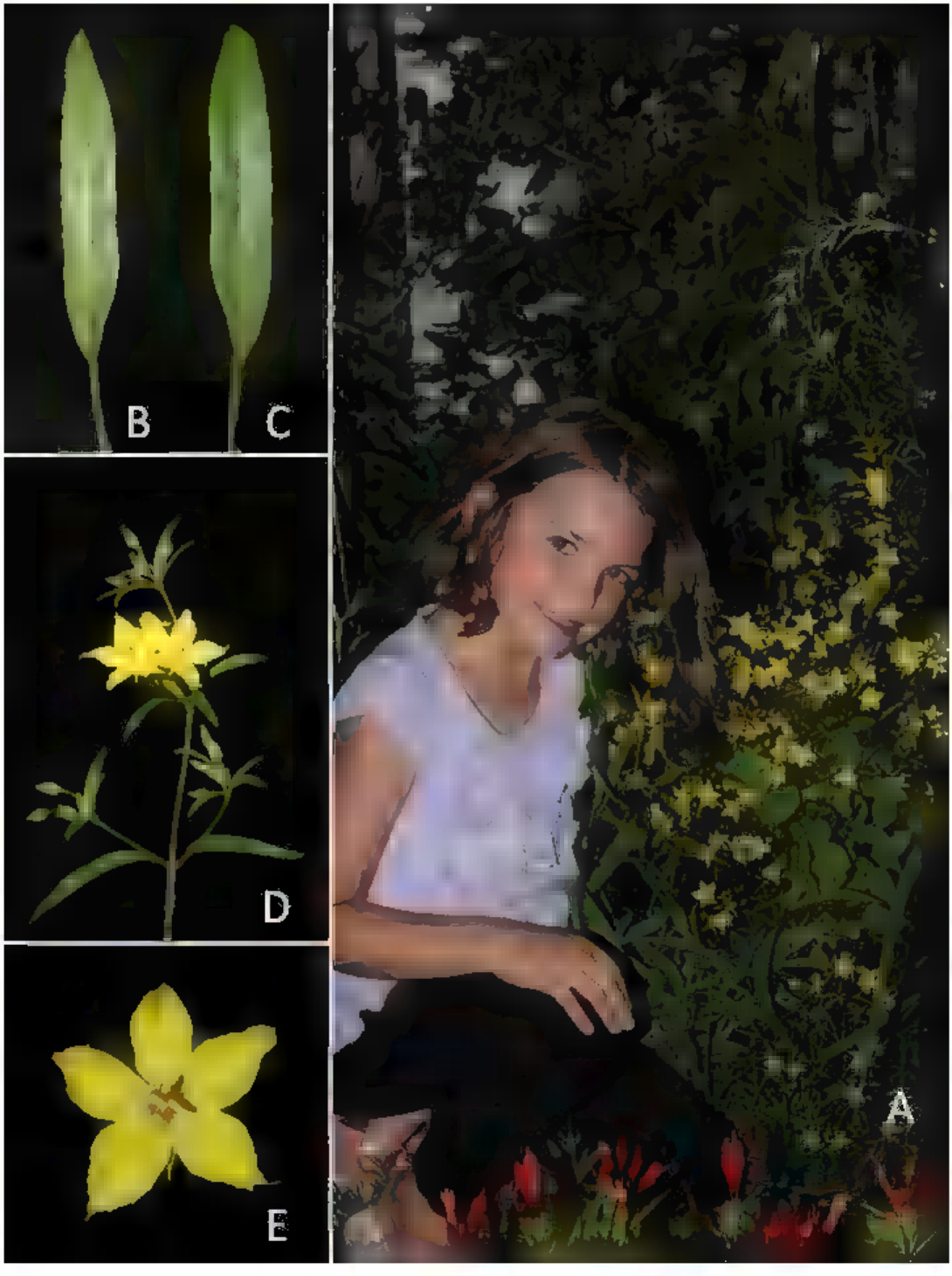

Figure 2. Photographic plate of *Lysimachia lewisii*. A. Habit of plant in first author's (Estes) garden. This plant is approximately 1 m tall, which is similar to that of plants in the wild. B-C. Mid-cauline leaves showing abaxial and adaxial surfaces, respectively. D. Portion of upper flowering branch; note recurving leaves. E. Flower adaxial view; note ovate corolla lobes with acuminate apices.

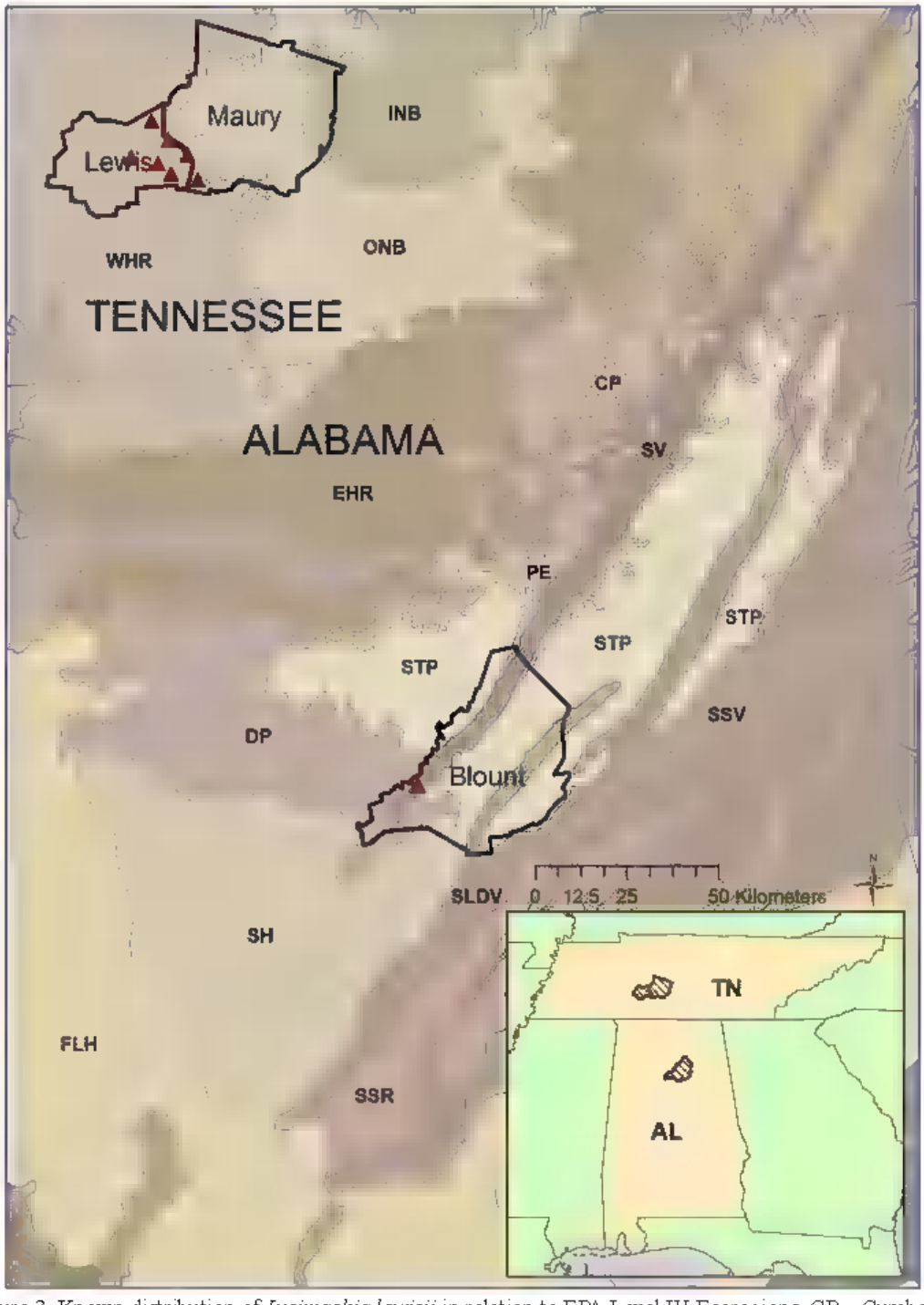

Figure 3. Known distribution of *Lysimachia lewisii* in relation to EPA Level IV Ecoregions. CP = Cumberland Plateau; DP = Dissected Plateau; EHR=Eastern Highland Rim; FLH = Fall Line Hills; INB = Inner Nashville Basin; ONB = Outer Nashville Basin; PE = Plateau Escarpment; SH = Shale Hills; SLDV = Southern Limestone and Dolomite Valleys; SSR = Southern Sandstone Ridges; SSV = Southern Shale Valleys; STP = Southern Table Plateau; SV = Sequatchie Valley.

Additional collections examined. **Tennessee**. Lewis Co.: Meriwether Lewis National Monument, Natchez Trace Parkway, roughly 6.5 mi SE of Hohenwald, 15 Jun 1946, *King 379* (US); "The Farm" swim hole along Cox Branch just upstream from confluence with Cow Pen Branch, 6.6 km by air NNW of Summertown, 14 Jul 2008, *Duke 62* with Estes (APSC); Meriwether Lewis State Park, TN, Natchez Trace Parkway, 7 mi E Hohenwald, 22 Jun 1982, *Carter 3072* (VDB); Natchez Trace Parkway, 4.6 mi NE Jct US 412, 1 Jun 1991, *Kral 78900* (VDB); Natchez Trace Parkway, Devil's Backbone, 14.7 km by air NE of Hohenwald, 31 Jul 2008, *Duke 89* with Estes (APSC, NCU, TENN, VDB); Big Swan Creek, 17 Jun 2003, *Bailey s.n.* with McCoy and Bowen (TENN); Cathey's Creek approximately 2.5 mi West of Maury Co. line on N. side of the creek, 27 Jun 1998, *Estes 00216* (TENN); Cathey's Creek Road, 16.7 km by air NE Hohenwald, 17 Jul 2008, *Duke 63* with Estes and Bailey (APSC); Langford Branch on Route 99, 6 Jun 1981, *DeSelm s.n.* (TENN); 8.3 km by road E of Gordonsburg, 0.5 km W of jct. of US Hwy 412 with Ridgetop Rd., headwaters area of Langford Branch, 14 Jul 2008, *Duke 60* with Estes (APSC, EKY, NCU, TENN, VDB); Overhead Bridge Road, 3.9 mi NW Mount Joy on N side of Overhead Bridge Road, 18 Jul 2008, *Duke 50* with Estes and Bailey (AMNH, APSC, NCU, TENN, UWAL, VDB); Ridgetop Road, 15.5 km by air ENE of Hohenwald, 17 Jul 2008, *Duke 41* with Estes and Bailey (APSC, GA, MISS, MO, NCU, TENN, UWAL, VDB, VPI); Walton Road, 6 km S by air from Hampshire (Maury Co.), just W of jct. of Walton Rd. and Baptist Branch Rd, 31 Jul 2008, *Duke 66* with Estes (APSC, VDB); Tiger Bennett Road, 15.1 km by air ESE of Hohenwald, 31 Jul 2008, *Duke 74* with Estes (APSC, FSU, NCU, TENN, UARK, VDB); Holloway Road, 3.7 km by air NE of Summertown, 31 Jul 2008, *Duke 73* with Estes (APSC). Maury Co.: by US 43, at first summit above Rockdale, 27 Jul 1972, *Kral 47836* (TENN, VDB); same site, 26 Jun 1970, *Kral 39749* (VDB); Brandon Lane, 5.3 km by air mi NW of Mount Joy on E side of Brandon Lane, 31 Jul 2008, *Duke 84* with Estes (APSC, JSU, NCU, UWAL, TENN, VDB); Baptist Branch Road, 5.3 km by air S of Hampshire, 31 Jul 2008, *Duke 67* with Estes (AMNH, APSC, NCU, TENN, UWAL, VDB); Stillhouse Hollow Falls State Natural Area, 5.1 km by air NE of Summertown, 14 Jul 2008, *Duke 57* with Estes (APSC, VDB); Rattlesnake Falls, 5.1 km by air ENE of Summertown, 14 Jul 2008, *Duke 64* with Estes (APSC); Rattlesnake Falls, 22 Jun 2000, *Estes 00756* with Chester (TENN). **Alabama**. Blount Co.: 2.5 air mi SW of Blount Springs, along US 31, 26 Jul 1997, *Keener 266* (UNA) with Haynes and Ginzbarg.

Etymology

The epithet *lewisii* is chosen to honor renowned early American explorer Meriwether Lewis (1774-1809), famous for co-leading the Lewis and Clark Expedition. The type locality of *Lysimachia lewisii* is located very near to where Lewis died mysteriously in 1809 along the Natchez Trace. Today the site is part of the Meriwether Lewis National Monument just off the Natchez Trace Parkway and is owned and managed by the US National Park Service. Lewis County, formed in 1843, was named in honor of Lewis. *Lysimachia lewisii* is nearly endemic to Lewis County with more 90 percent of the known occurrences restricted to the eastern third of the county.

Phenology

Lysimachia lewisii flowers from May to August with fruits developing from July to September.

Distribution and Ecology

Lysimachia lewisii is nearly endemic to the dissected uplands of the Western Highland Rim of south-central Tennessee and the Cumberland Plateau of northern Alabama (Figure 3). In Tennessee it is restricted to eastern Lewis County (headwaters region of Langford Branch, Big Swan Creek, Little Swan Creek, Cathey's Creek, and Big Bigby Creeks) and extreme southwestern Maury County (headwaters of Falls Creek and Big Bigby Creek). Searches in nearby portions of Giles, Hickman, and Lawrence counties have not been successful. Given the very narrow range of *L. lewisii* in Tennessee, it was quite surprising to discover herbarium specimens documenting its collection 175 km to the south in Blount County, Alabama. The Alabama populations are found in the drainage of the Mulberry Fork of the Black Warrior River in the Dissected Southern Cumberland Plateau Ecoregion (Griffith et al. 2001).

Tennessee populations are associated with xeric to submesic, acidic, oak-hickory woodlands and forests (Fig. 4) developed over Mississippian-aged Fort Payne chert and are within the Western Highland Rim Ecoregion (Griffith et al. 1998), part of the Interior Low Plateaus Physiographic Province. Tennessee populations occur at elevations ranging from 267-320 meters above sea level. The single known Alabama population occurs on a dry, acidic, forested, upper slope similar to that of Tennessee populations. The geology at the Alabama site is also of Mississippian age but the population occurs at or near the contact zone between the Fort Payne chert and the Hartselle sandstone at an elevation of approximately 160 meters above sea level.

Figure 4. Typical dry woodland habitat of *Lysimachia lewisii*, near Rattlesnake Falls, Maury County, Tennessee. Photo by Dwayne Estes, 17 May 2011.

Many of the known populations of *Lysimachia lewisii* occur in relatively closed oak-hickory forests. Under these conditions this species is usually quite rare with low population density and few individuals restricted to light gaps or trails. The largest populations tend to occur in open woodlands or woodland edges (30-70% canopy coverage) with a rich herbaceous understory. Some of these are associated with roadside embankments along the edge of dry oak-hickory woodlands. It is quite likely that historically (especially prior to the widespread construction of roads) these sites would have been fire-maintained woodlands. Fire has been largely suppressed from these woodlands for several decades and in its absence *L. lewisii* has taken refuge in edges, roadside embankments, trail margins, and light gaps because these sites provide open habitats that simulate the historical nature of the open, fire-dependent woodlands that would have kept the canopy in a more open state.

Tree species commonly associated with *Lysimachia lewisii* include *Carya tomentosa*, *Nyssa sylvatica*, *Oxydendrum arboreum*, *Quercus alba*, *Q. coccinea*, *Q. montana*, and *Q. stellata*. Shrubs and woody vines include *Amelanchier arborea*, *Hypericum hypericoides*, *H. stragulum*, *Rhododendron alabamense*, *Smilax glauca*, *S. rotundifolia*, *Toxicodendron radicans*, *Vaccinium pallidum*, *V. stamineum*, and *Vitis aestivalis*. Common herbs include *Chimaphila maculata*, *Coreopsis major* var. *major*, *Cunila origanoides*, *Eupatorium pubescens*, *Solidago erecta*, *S. hispida*, *S. nemoralis*, *S. odora*, *Pteridium aquilinum*, *Symphyotrichum patens*, and *Tephrosia virginiana*.

Conservation

We suggest this species should be considered for state-listing as a rare species in both Alabama and Tennessee and we recommend a global rank of G2 since there are fewer than 20 known populations comprising less than 3,000 individuals (suggested ranks follow guidelines by NatureServe 2015). We suggest this species be given a state rank of S1 in Alabama and S2 in Tennessee. This rare species seems to be limited to the Duck River Drainage Basin in Tennessee and the Mulberry Fork of the Warrior River Drainage in Alabama. Population density is usually low and more rigorous assessment is needed. Primary threats to this species may include prolonged fire suppression, conversion of forests and woodlands to loblolly pine plantations, and residential development. The impact from invasive species on *Lysimachia lewisii* seems to be minimal at this point.

Taxonomic discussion

Lysimachia has traditionally been assigned to the Primulaceae (e.g., Coffey & Jones 1980) but some have proposed that the family be subdivided into a number of smaller families. Under this narrower concept *Lyismachia* has been assigned to the Myrsinaceae (Anderberg & Ståhl 1995; Hao et al. 2004). It seems that the broad concept of Primulaceae sensu lato is now again favored (Stevens 2001 onwards). The issue of family placement is beyond this publication but we follow Stevens (2001 onwards) in recognizing *Lysimachia* as a member of the Primulaceae.

Lysimachia is widely distributed in the Northern Hemisphere with the highest diversity occurring in southwestern China (Hu 1994; Hu & Kelso 1996). 12 species are native to North America with most of these centered in the eastern and southeastern portion of the USA. Ray (1956) assigned the North American species to four subgenera. The largest of these, subg. *Seleucia* Bigelow, is characterized by opposite, entire, and glabrous leaves, presence of staminodia, super-volute corolla lobes (each petal encloses a fertile stamen in bud), and a distinct pollen morphology (Coffey & Jones 1980). Coffey and Jones (1980) treated the same group as sect. *Seleucia* and recognized seven species: *L. ciliata* L., *L. graminea* (Greene) Hand.-Maz., *L. hybrida*, *L. lanceolata*, *L. quadriflora*, *L. radicans* Hook., and *L. tonsa*.

Past collections of *Lysimachia lewisii*, collected from 1946-2003, have been identified as *L. hybrida*, *L. lanceolata*, *L. tonsa*, and *L. quadriflora*. In its overall gestalt, *L. lewisii* (Fig. 1) most closely resembles *L. hybrida* (Fig. 5). In fact, collections made by the first author in 1998 and 2000 were initially identified as *L. hybrida*. The nature of the petioles and preference for wetland habitats immediately separates *L. hybrida*. Some collectors identified specimens of *L. lewisii* as *L. lanceolata* but that species differs in its smaller stature, rhizomatous habit, and leaves with shorter petioles that are ciliate throughout (Fig. 6). *Lysimachia lewisii* is perhaps most closely related to *L. tonsa* (Fig. 7), *L. radicans* (Fig. 8), and *L. quadriflora* (Fig. 9). Among these three species, *L. lewisii* shares the same distribution of cilia, which are restricted to nodal regions and do not extend up the petioles. Most specimens of *L. tonsa* have broadly ovate leaves and are clearly distinct from *L. lewisii* although a few populations on dry oak-pine ridges in east-central Alabama (Talladega Mountains) and west-central Georgia (Pine Mountain) are narrowly ovate. *Lysimachia lewisii* is the only entity within subg. *Seleucia* with the following characteristics: narrowly elliptic-lanceolate and distinctly petiolate leaves, eciliate petioles, non-rhizomatous habit, and dry-xeric upland oak-hickory woodland habitat.

Figure 5. *Lysimachia hybrida*. This species resembles *L. lewisii* but differs in its preference for wetland habitats, leaves often widest below the middle, petioles ciliate in the proximal half, and lower stems often enlarged in diameter and with adventitious roots.

Figure 6. *Lysimachia lanceolata* (broad-leaved form). This is the form typical of the interior portions of the eastern USA. It mostly occurs west of the Appalachian Plateaus westward to the Great Plains. It differs from *L. lewisii* in its shorter petioles that are ciliate throughout, generally different leaf shape, more rounded corolla lobes, smaller stature, and creeping rhizomatous habit.

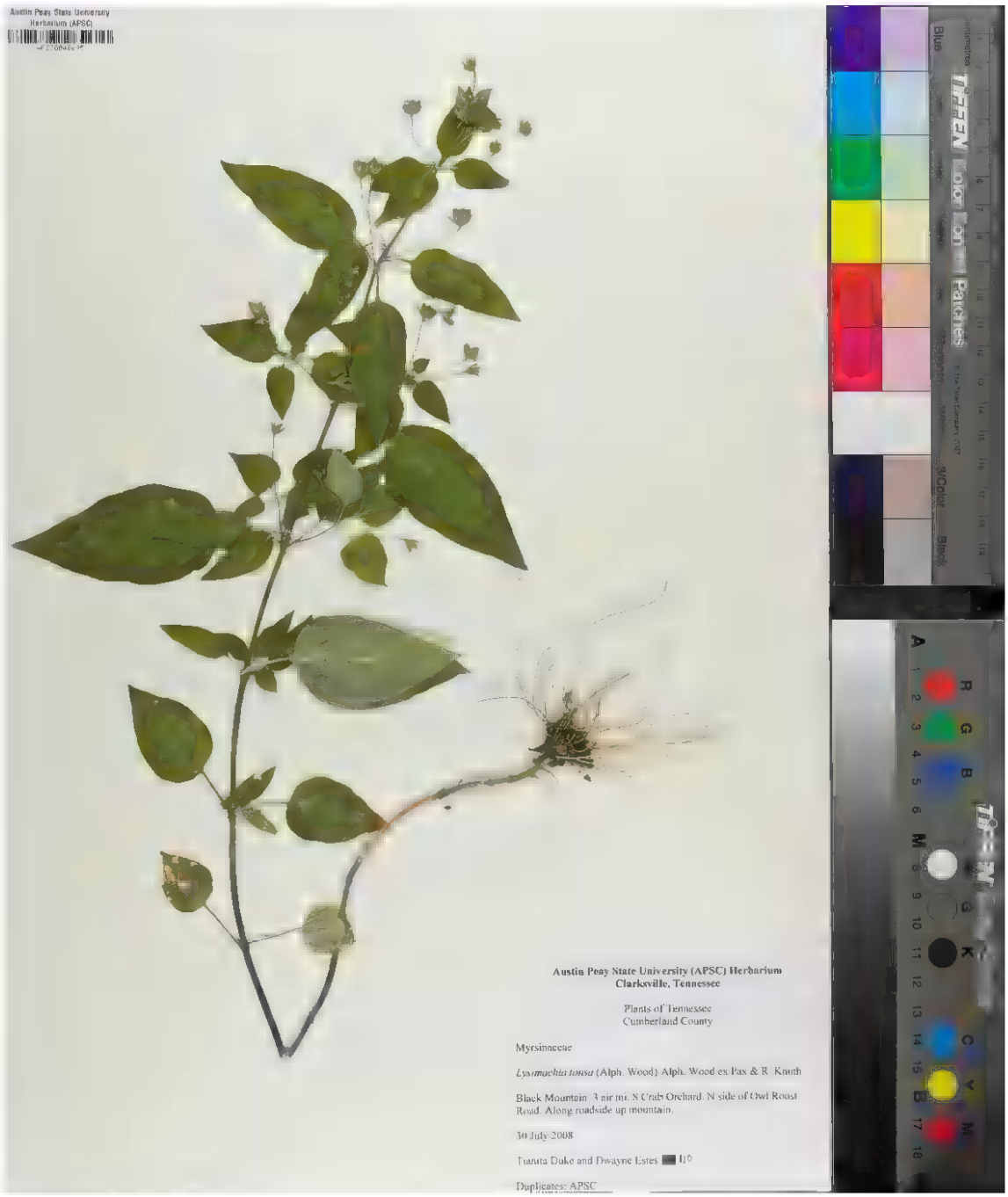
Austin Peay State University
Herbarium (APSC)
Austin Peay State University (APSC) Herbarium
Clarksville, Tennessee
Plants of Tennessee
Cumberland County
Myrsinaceae
Lysimachia tonsa (Alph. Wood) Alph. Wood ex Pax & R. Knuth
Black Mountain. 3 air mi. S Crab Orchard. N side of Owl Roost Road. Along roadside up mountain.
30 July 2008
Turuta Duke and Dwayne Estes
Duplicates: APSC

Figure 7. *Lysimachia tonsa*. *Lysimachia lewisii* has been identified by some authors as *L. tonsa*, a species, which usually has ovate to ovate-lanceolate leaves. The two species are similar in their glabrous petioles with cilia confined to the very base at the node and in their preference for growing in dry to submesic acidic woodlands.

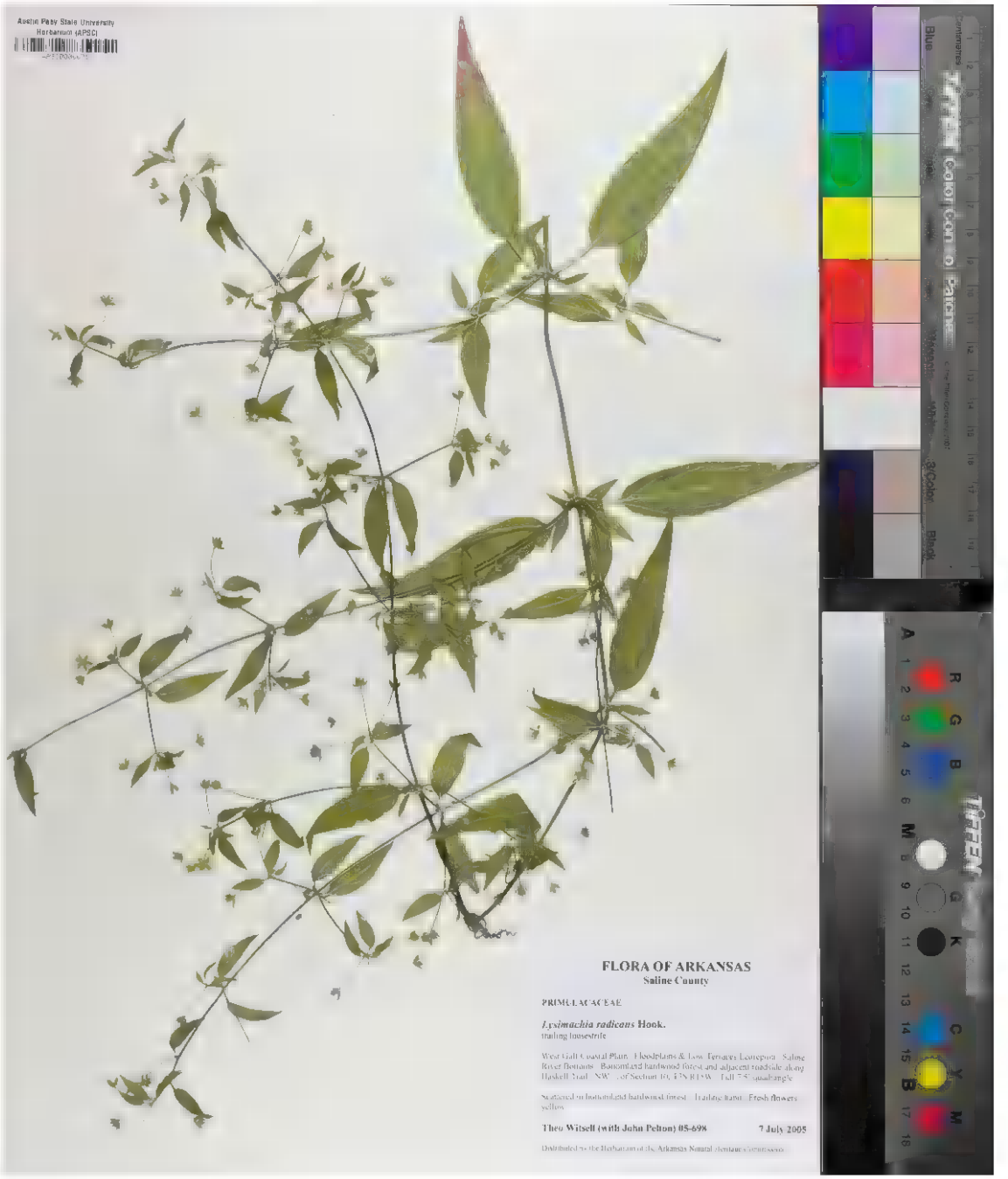

Figure 8. *Lysimachia radicans*. This species is similar to *L. lewisii* but differs in its decumbent habit, in stems rooting at the nodes, leaves which are typically widest below the middle, much smaller flowers, and preference for growing in swamps and marshes.

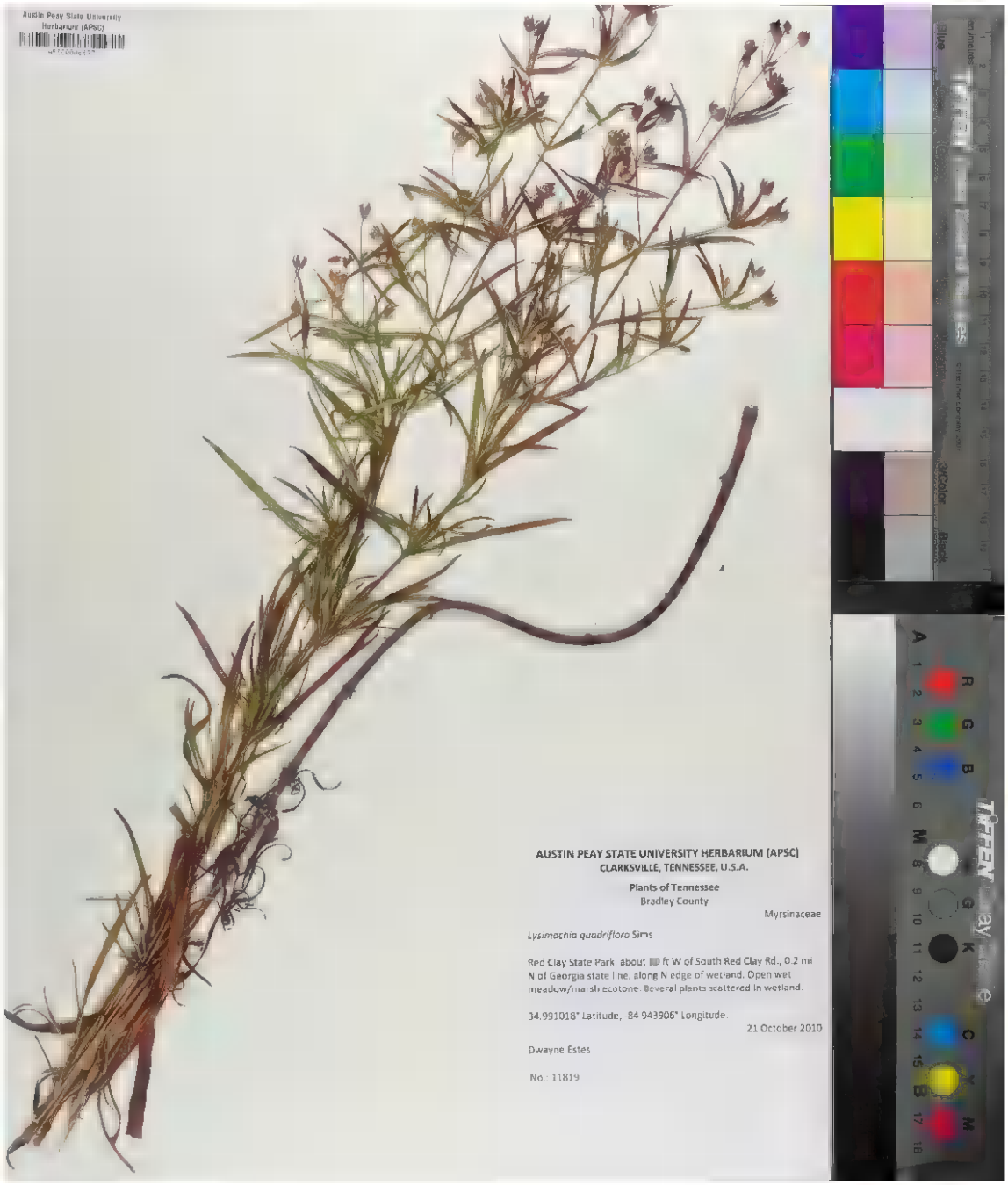
Austin Peay State University
Herbarium (APSC)
AUSTIN PEAY STATE UNIVERSITY HERBARIUM (APSC)
CLARKSVILLE, TENNESSEE, U.S.A.
Plants of Tennessee
Bradley County
Myrsinaceae
Lysimachia quadriflora Sims
Red Clay State Park, about 100 ft W of South Red Clay Rd., 0.2 mi N of Georgia state line, along N edge of wetland. Open wet meadow/marsh ecotone. Several plants scattered in wetland.
34.991018° Latitude, -84.943906° Longitude.
21 October 2010
Dwayne Estes
No.: 11819

Figure 9. *Lysimachia quadriflora*. Some specimens of *Lysimachia lewisii* may resemble broad-leaved extremes of *L. quadriflora*. *Lysimachia quadriflora* differs in its consistently narrower leaves that are sessile to subsessile, leaf margins that are frequently revolute (at least on specimens), and preference for growing in calcareous wetlands and damp streambanks.

Below is an updated key is provided to distinguish the entities of subg. *Seleucia* in Alabama and Tennessee.

Key to the species of *Lysimachia* subg. *Seleucia*

1. Leaves linear, 1–7 mm wide, 10–20× longer than wide, mid-cauline leaves sessile or short petiolate, petioles when present 1–5 mm long.

   2. Stems 2–10 dm tall; petioles with cilia at base only, rarely ciliate their entire length, cilia not extending onto margins of leaf bases; flowers 16–26 mm in diameter **Lysimachia quadriflora**
   2. Stems 1–3 dm tall; petioles ciliate their full length with cilia usually extending distally onto margins of leaf base; flowers 7–20 mm in diameter.

      3. Leaves 1–2 (3) mm wide; flowers 7–14 mm in diameter ..... **Lysimachia graminea**
      3. Leaves 3–7 mm wide; flowers 11–20 mm in diameter **Lysimachia lanceolata (narrow form)**

1. Leaves lanceolate, narrowly elliptic-lanceolate, or narrowly oblong, 5–60 mm wide, mostly 1.5–10× longer than wide, mid-cauline leaves usually with well-developed petioles 5–20+ mm long (except in *L. lanceolata* where petioles are mostly <5 mm).

   4. Petioles ciliate along their entire length.

      5. Leaves ovate to ovate-lanceolate, 17–60 mm wide ..... **Lysimachia ciliata**
      5. Leaves narrowly oblong, elliptic, lanceolate, or oblanceolate, 5–20 mm wide.

         6. Plants lacking creeping rhizomes; stem bases usually somewhat swollen and >4 mm in diameter, often with adventitious roots; leaf bases mostly rounded to broadly cuneate; petioles ciliate mostly only in basal half but sometimes with a few cilia extending into distal half of petiole; plants of wetlands ..... **Lysimachia hybrida**
         6. Plants with well-developed long-creeping rhizomes; stem bases not swollen, <4 mm in diameter, lacking adventitious roots; leaf bases cuneate; petioles evenly ciliate from petiole base to apex and extending onto lower leaf edge; plants of mesic to dry sites, rarely of wet areas ..... **Lysimachia lanceolata (broad form)**

   4. Petioles eciliate or with cilia confined to proximal half only.

      7. Stems decumbent to prostrate and often rooting at the nodes; corolla lobes 3–5 mm long ..... **Lysimachia radicans**
      7. Stems erect or sometimes reclining on other vegetation but not prostrate and rooting at the nodes; corolla lobes 5–12 mm long.

         8. Cilia extending up proximal half of petioles; plants of wetlands; stem bases usually somewhat swollen and often with adventitious roots ..... **Lysimachia hybrida**
         8. Cilia absent from petioles, restricted to the nodal region between opposing petiole bases; plants of dry to mesic upland habitats; stem bases not swollen, lacking adventitious roots.

            9. Leaves ovate to ovate-lanceolate, bases rounded to truncate, abruptly contracted to the petiole, widest point located in the proximal one-quarter to one-third of the blade, 1.5–4.5× longer than wide, mid-cauline leaves 15–44 mm wide ..... **Lysimachia tonsa**
            9. Leaves narrowly lanceolate, bases cuneate and generally gradually contracted to the petiole, widest point located near the middle to just below the middle of the blade, 4–9× longer than wide, mid-cauline leaves 5–12 mm wide ..... **Lysimachia lewisii**

ACKNOWLEDGEMENTS

We wish to acknowledge Tianita Duke and Claude Bailey for assistance with field and herbarium work. The Austin Peay State University Center for Excellence in Field Biology and the Botanical Research Institute of Texas provided financial support. We also are grateful to the following herbaria that loaned specimens for study: APSC, BRIT, EKY, GA, MISS, MO, NCU, NY, SMU, TENN, UNA, VDB.

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VALIDATION AND LECTOTYPIFICATION OF *PACKERA CRAWFORDII* (ASTERACEAE)

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ABSTRACT

Senecio crawfordii has generally been regarded as a synonym in recent decades, as phylogenetic studies resulted in most eastern North American *Senecio* being transferred to *Packera*. Recent research, however, indicates the taxon should be recognized at species rank. Until a fuller accounting of its distinctiveness is made, its validation in *Packera* is urgently needed for conservation assessments and use in impending floras, thus the combination is made here as **Packera crawfordii** (Britton) A.M. Mahoney & R.R. Kowal, **comb. nov.** A specimen at NY is designated as the lectotype.

In 1901, N.L. Britton described *Senecio crawfordii* Britton, a wetland species of eastern North America. Although accepted as a species during the first half of the 20th century (Fernald 1950), the taxon has since been treated as an infraspecific taxon of the species now known as *Packera paupercula* (Michx.) Á. Löve & D. Löve (Barkley 1962), or Britton's binomial has been reduced to synonymy under that species (Radford et al. 1968; Gleason & Cronquist 1991). However, the taxon's morphological, ecological, reproductive, and cytological distinctiveness argue for its recognition at species rank within *Packera* (Kowal & Mahoney, in press).

Packera crawfordii (Britton) A.M. Mahoney & R.R. Kowal, **comb. nov.** Basionym: *Senecio crawfordii* Britton, Torreya 1: 21. 1901. *Senecio balsamitae* Muhl. ex Willd. var. *crawfordii* (Britton) Greenm., Rhodora 10: 69. 1908. *Senecio pauperculus* var. *crawfordii* (Britton) T.M. Barkley, Trans. Kansas Acad. Sci. 65: 357. 1962. *Senecio pauperculus* subsp. *crawfordii* (Britton) G.W. Douglas & G. Ruyle-Douglas, Canad. J. Bot. 56: 1710. 1978. **LECTOTYPE** (designated here): **USA. Pennsylvania**. Bucks Co.: Tullytown, 29 May 1899, *N.L. Britton s.n.* (NY).

Packera crawfordii has a very scattered distribution from New Jersey and eastern Pennsylvania west to northern Indiana and northern Illinois, south to southeastern North Carolina, western North Carolina, west-central Georgia, and western Tennessee. It occurs mainly in mucky wetland soils and appears to be very rare range-wide, based on documented occurrences. A more

detailed paper is in preparation (Kowal & Mahoney, in press), but validation of the name is needed for its imminent use in the *Flora of Tennessee* (Tennessee Flora Committee, in press) and the *Flora of the Southern and Mid-Atlantic States* (Weakley, in press) and to encourage conservation assessment of this rare and specialized species.

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BARCODING THE ASTERACEAE OF TENNESSEE, TRIBE CICHORIEAE

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ABSTRACT

Results from barcoding studies of tribe Cichorieae for the Tennessee flora using data from the nuclear ribosomal ITS marker region are presented and include first complete reports of this marker for 15 of the 24 species of the tribe that are native to the state. Sequence data from the ITS region separated all genera of Cichorieae in Tennessee from one another, and almost all species of the introduced *Cichorium*, *Crepis*, *Hypochaeris*, *Lapsana*, *Leontodon*, and *Hieracium* subgen. *Pilosella* from one another. In contrast, many (though not all) species of the native members of *Hieracium*, *Krigia*, *Lactuca*, and *Nabalus* were not uniquely distinguished by this marker. ITS sequence data provided support for the recognition of *Nabalus* as distinct from *Prenanthes*, and helped to confirm the identification of *N. albus* samples newly reported for Tennessee. ITS sequence data also suggested that *N. cylindricus* may represent a species distinct from *N. roanensis*, with which it has been lumped. The results of this study suggest that further study is needed to clarify patterns of diversification in the four genera of Cichorieae that exhibit radiations in southeastern North America.

Tribe Cichorieae is one of the most morphologically distinctive tribes in Asteraceae and with more than 1600 species one of the larger ones (Kilian et al. 2009). The tribe has traditionally been considered to have two prominent apomorphies in milky sap and homogamous ligulate heads and at earlier times was regarded as a separate subfamily or even family (e.g. Cronquist 1980). Molecular data have been decisive, however, in placing it as just one of several tribes, including Arctotidinae and Vernonieae, that form the subfamily Cichorioideae (Funk & Chan 2009). Like many groups that are highly distinctive, classification of subordinate groups of the tribe remains problematic and generic distinctions are still being refined. Thus, the separation of *Nabalus* as distinct from *Prenanthes* has only recently been accepted (Killian et al. 2009), and the circumscription of *Lactuca* remains problematic. The current study contributes further support for recognition of *Nabalus* as a distinct genus and continues the effort to survey the molecular diversity found in species of Asteraceae in Tennessee (Schilling 2013; Schilling & Floden 2012, 2013, 2014; Schilling et al. 2014), with further documentation of the varied diversification patterns that are found in members of the family.

Cichorieae is most diverse in temperate regions, with the largest concentration of species occurring in the Eastern Hemisphere (Kilian et al. 2009). The tribe is represented in Tennessee by 14 genera and 42 species, of which almost half are introduced; only 5 genera and 24 species are considered to be native (Chester et al. 2009). The larger genera are, however, composed mostly or entirely of native species and include *Hieracium* (7 species, 5 native), *Krigia* (5 species, all native), *Lactuca* (7 species, 5 native), and *Nabalus* (8 species, all native). Several species are considered to be rare in the state, including *Hieracium longipilosum*, *Krigia montana*, *Nabalus albus*, *N. asper*, and *N. barbatus* (Crabtree 2014); of these only *K. montana* and *N. barbatus* are somewhat rare globally (G3 ranking).

The goal of this study was to sample the nuclear ribosomal ITS marker for all species of Cichorieae that occur in Tennessee. Particular emphasis was placed on the four larger native genera, each of which exhibit modest radiations in southeastern North America. Despite the fact that Cichorieae is the most well studied tribe of Asteraceae (Kilian et al. 2009), most species from southeastern North America (with the exception of *Krigia*; Kim & Jansen 1994) have not been included in molecular phylogenetic studies. Sampling of additional species of these genera from areas of southeastern North America outside of Tennessee was done to evaluate overall patterns of diversification and compare them to other Asteraceae genera of the region.

Materials and methods

DNA was extracted from leaf samples either collected fresh or taken from herbarium specimens (Table 1). For most samples the DNeasy Plant Mini Kit protocol (Qiagen, Valencia CA) was used. PCR amplifications and sequencing of the ITS region followed Schilling et al. (2007). A few samples required the use of the internal primers, "5.8S 79 for" and "ITS 5.8SR," for sequencing to obtain clean sequence, either because of fungal contamination or because of length polymorphisms (Schilling et al. 2007). GenBank accession numbers are provided in Table 1. Although this study was not designed to undertake a rigorous phylogenetic analysis, a maximum likelihood tree was generated using MEGA 6 (Tamura et al. 2013) to provide a convenient way to make a comparative visualization of the sequence results. The samples of the introduced *Tragopogon* were utilized as the outgroup, based on results of Kilian et al. (2009). The analysis also incorporated sequences deposited at GenBank of conspecific samples or closely related species.

Table 1. Plant material used for ITS barcoding studies of Cichorieae. All voucher specimens at TENN.

Species	DNA#	Genbank	Voucher info
CICHORIUM L.			
C. intybus L.	2644	HQ172904	*Schilling 07-DNA2644*, Knox Co., Tenn.
CREPIS L.			
C. capillaris (L.) Wallr.	3018	HQ161936	*Fleming FCF-533*, Van Buren Co., Tenn.
C. pulchra L.	3019	HQ161937	*Fusiak 525*, Knox Co., Tenn.
C. setosa Haller f.	3020	HQ161938	*Wofford 79-139*, Greene Co., Tenn.
HIERACIUM L.			
H. caespitosum Dumort.	3005	HQ161951	*DeSelm s.n.*, 5/29/2001, Washington Co., Tenn.
H. gronovii L.	2521	HQ161948	*Schilling 2521*, Knox Co., Tenn.
H. longipilum Torr. ex Hook.	3003	HQ161949	*Chester 13138*, Stewart Co., Tenn.
H. paniculatum L.	2568	HQ161947	*Schilling CF-7*, Sullivan Co., Tenn.
H. pilosella L.	3021	HQ161945	*Powers s.n.* 6/6/2008, Cumberland Co., Tenn.
H. scabrum Michx.	3004	HQ161950	*DeSelm 01-222*, Johnson Co., Tenn.
H. venosum L.	2573	HQ161946	*Schilling CF10*, Sullivan Co., Tenn.
	3272	KP828834	*Thomas 173842*, Sevier Co., Tenn.
Non-Tennessee samples			
H. megacephalon Nash	3262	KP828831	*McNeilus 00-33*, DeSoto Co., Fla.
	3263	KP828832	*Kral 64068*, Martin Co., Fla.
H. traillii Greene	3267	KP828833	*Christy F/6*, Bath Co., Va.
	3285	KP828835	*Wieboldt 5215*, Bath Co., Va.
HYPOCHAERIS L.			
H. radicata L.	3022	HQ161932	*McNeilus 01-171*, Knox Co., Tenn.

KRIGIA Schreb.			
K. biflora (Walt.) S.F. Blake	3015	HQ161943	*Schilling DNA3015*, Campbell Co., Tenn.
K. cespitosa (Raf.) Chambers	3023	HQ161942	*McNeilus 99-113*, Jackson Co., Tenn.
K. dandelion (L.) Nutt.	3024	HQ161941	*McNeilus 97250*, Monroe Co., Tenn.
K. montana (Michx.) Nutt.	3050	HQ172903	Greenhouse plant
K. virginiana (L.) Willd.	2772	HQ161940	*Schilling DNA2772*, Knox Co., Tenn.
LACTUCA L.			
L. biennis (Moench) Fernald	3006	HQ161959	*Estes 9543*, Morgan Co., Tenn.
	3160	KP828828	*Schilling LB1*, Knox Co., Tenn.
L. canadensis L.	2587	HQ161956	*Schilling 07-DNA2587*, Knox Co., Tenn.
	3200	KP828829	*Schilling DNA3200*, Knox Co., Tenn.
L. floridana (L.) Gaertn.	2570	HQ161957	*Schilling CF-1*, Sullivan Co., Tenn.
	3159	KP828827	*Schilling LF-1*, Knox Co., Tenn.
L. graminifolia Michx.	3261	KP828830	*Floden 2139*, Polk Co., Tenn.
L. saligna L.	3026	HQ161960	*Beck 6311*, Marion Co., Tenn.
L. serriola L.	3049	HQ172902	*Estes 1084*, Maury Co., Tenn.
Non-Tennessee samples			
L. graminifolia Michx.	3008	HQ161958	*Rogers 5247*, Copiah Co., Miss.
L. hirsuta Muhl. ex Willd.	3048	HQ172901	*Floden 941*, Oregon Co., Ark
LAPSANA L.			
L. communis L.	3027	HQ161939	*DeSelm s.n.*, 6/14/2005, Claiborne Co., Tenn.
LEONTODON L.			
L. saxatilis L.	4251	KP828825	*Floden et al.2789* , Fentress Co., Tenn.
	4250	KP828826	*Floden & Fleming 5/14/2012*, Polk Co., Tenn.
NABALUS Cass.			
N. albus (L.) Hook.	2840	HQ162003	*Floden763*, Campbell Co., Tenn.
	2963	HQ162005	*DeSelm s.n.*, Knox Co., Tenn.
N. altissimus (L.) Hook.	2832	HQ161970	*Estes 1479*, Giles Co., Tenn.
	2948	HQ161971	*Marcum et al. PBM1683*, Blount Co., Tenn.
N. asper (Michx.) Torr. & A. Gray	2955	HQ161988	*McKinney & Jackson 6892*, Coffee Co., Tenn.
	3042	HQ161979	*Horn 98-54*, Franklin Co., Tenn.
N. barbatus Torr. & A. Gray	2834	HQ161979	*Horn 98-60*, Coffee Co., Tenn.
	3041	HQ161981	*Gunn S6-792*, Humphreys Co., Tenn.
N. crepidineus (Michx.) DC.	2835	HQ161984	*Sweetser s.n.*, 9/26/2003, Knox Co., Tenn.
N. roanensis Chickering	2836	HQ161993	*Fusiak 580*, Carter Co., Tenn.
	2950	HQ161994	*Busemeyer et al. 756*, Blount Co., Tenn.
	2981	HQ161997	*DeSelm s.n. 8/31/2000*, Greene Co., Tenn.
	2979	HQ161995	*Fusiak 571*, Polk Co., Tenn.
	2980	HQ161996	*Murrell 953*, Polk Co., Tenn.
	2978	HQ161998	*Fusiak 571*, Unicoi Co., Tenn.
	2956	HQ162000	*Wofford 79-277*, Unicoi Co., Tenn.
N. serpentarius (Pursh) Hook.	2646	HQ161990	*Schilling 07-DNA2646*, Knox Co., Tenn.
	2837	HQ161989	*Estes & Beck 8352*, Grundy Co., Tenn.
	2952	HQ161991	*Rogers 42438*, Sevier Co., Tenn.
N. trifoliolatus Cass.	2838	HQ161976	*Murrell 620*, Polk Co., Tenn.
	2565	HQ161975	*Schilling CF-9*, Sullivan Co., Tenn.

Non-Tennessee samples

N. albus (L.) Hook.	2831	HQ162002	*McNeilus 93-2215*, Wood Co., Wis.
	2962	HQ162004	*Jones s.n.*, 9/11/1976, Erie Co., Ohio
	2964	HQ162001	*Morton 7990*, Hardy Co., W.Va.
N. asper (Michx.) Torr. & A. Gray	2954	HQ161987	*Athey 1470*, McCracken Co., Ky.
N. autumnalis (Walt.) Weakley	2959	HQ162007	*Pringle 31236*, Swain Co., N.C.
N. barbatus Torr. & A. Gray	3040	HQ161980	*Kral 37700*, Etowah Co., Ala.
N. crepidineus (Michx.) DC.	3045	HQ161984	*Athey 2932*, Graves Co., Ky.
N. racemosus (Michx.) Hook.	2960	HQ162009	*McNeilus 90-981*, 9/26/2003, Norman Co., Minn.
N. roanensis Chickering	2951	HQ161992	*Busemeyer et al. 780*, Swain Co., N.C.
N. trifoliolatus Cass.	2949	HQ161974	*Phillippe 31167*, Swain Co., N.C.
PRENANTHES L.			
P. purpurea L.	2965	HQ161931	*Schilling 09-01*, Baden-Württemberg, Germany
PYRRHOPAPPUS DC.			
P. carolinianus (Walt.) DC.	2519	HQ161944	*Schilling 07-DNA2519*, Knox Co., Tenn.
SONCHUS L.			
S. arvensis L.	3029	HQ161952	*DeSelm s.n.*, 7/12/1997, Campbell Co., Tenn.
S. asper (L.) Hill	3030	HQ161953	*Thomas 173736*, Sullivan Co., Tenn.
S. oleraceus L.	3031	HQ161955	*Estes 2617*, Bedford Co., Tenn.
TARAXACUM Wiggers			
T. erythrospermum Andrz. ex Besser	3032	HQ161933	*Estes 1974*, Giles Co., Tenn.
T. officinale Wiggers	2531	HQ161934	*Schilling 07-DNA2531*, Knox Co., Tenn.
TRAGOPOGON L.			
T. dubius Scop.	2332	HQ161962	*Schilling2332*, Knox Co., Tenn.
T. porrifolius L.	3033	HQ161961	*Fusiak 523*, Knox Co., Tenn.
YOUNGIA Cass.			
Y. japonica (L.) DC.	3017	HQ161935	*Schilling 10-1*, Knox Co., Tenn.

Results and discussion

Newly obtained ITS sequences for Cichorieae ranged in length from 623-647 bp. The range for species native to Tennessee was narrower, between 638 (*Pyrrhopappus*) and 642 (*Nabalus*, uniform in all species sampled); *Hieracium* was consistently 640, *Krigia* was 640-641, and the widest infrageneric variation among natives was in *Lactuca* (639-641). Among native species, the occurrence of length polymorphisms was limited to the sample of *Krigia montana*, which is known to be an allopolyploid (Kim & Jansen 1994). The number of positional polymorphisms (inferred from a double peak on the sequencing electropherogram) was relatively low for all samples, varying from none to six in individual samples. The relatively low number of polymorphisms in Cichorieae ITS sequences contrasts to frequent polymorphism occurrences in other Asteraceae of the southeastern USA, such as Coreopsideae (Schilling et al. 2014).

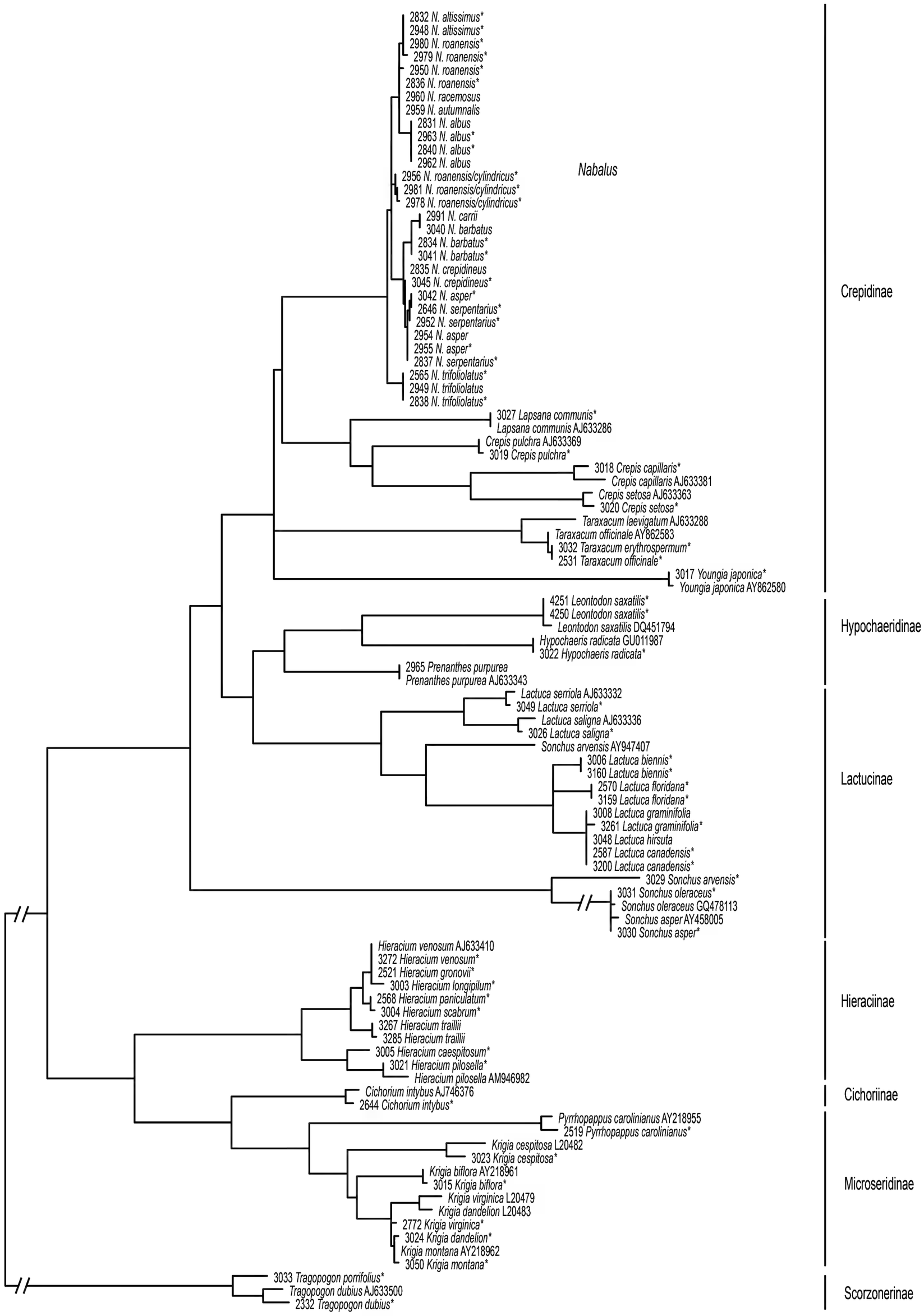

Figure 1. Maximum likelihood bootstrap tree (100 replicates) showing relationships of species of Cichorieae based on ITS sequence data, using *Tragopogon* as the outgroup. Subtribes of Cichorieae shown along right margin. Newly obtained sequences designated by DNA number preceding species name (Table 1); GenBank numbers for other sequences follow species name. *= sample from Tennessee.

The ITS sequences of the sampled genera of Cichorieae were quite different from one another (Figure 1). The overall placement in the ML tree was consistent with the subtribal circumscriptions of Kilian et al. (2009). The four native genera that have radiated in eastern North America are each placed in a different subtribe. This is notable for *Nabalus*, which as a member of Crepidinae is phylogenetically distant from *Prenanthes* (Hypochaeridinae), with which it has been frequently lumped. For Cichorieae of Tennessee, an ITS sequence will clearly identify an unknown sample at least to genus.

For the introduced genera, including *Cichorium*, *Crepis*, *Hypochaeris*, *Lapsana*, *Leontodon*, and *Hieracium* subgen. *Pilosella*, species were distinct from one another based on ITS sequences (Fig. 1), with two exceptions. There was no clear separation between *Sonchus asper* and *S. oleraceus*, although both were distinct from *S. arvensis* (Fig. 1). And within *Taraxacum*, a Tennessee sample identified originally as *T. laevigatum* and annotated later as *T. erythrospermum* did not differ in ITS sequence from samples of *T. officinale*, although a Genbank sample of *T. laevigatum* (and also one of *T. erythrospermum*, not shown) was clearly distinct. Species level identification in *Taraxacum* is complicated by both morphological plasticity and by a mixed apomictic and sexual breeding system (Kirschner et al. 2014), and further study is needed to confirm that more than a single species is actually present in Tennessee.

Differentiation at the species level based on ITS sequences was less well resolved for the native genera. *Krigia* was the best resolved, although the complications introduced by polyploidy and possible hybridization (Kim & Jansen 1994) appear to be reflected in the lack of separation among *K. montana*, *K. dandelion*, and *K. virginica* (Fig.1). Within *Hieracium*, the native species, which are all sexual and diploid, were clearly separated as a group from the Eurasian apomicts *H. pilosella* and *H. caespitosum*, consistent with the results from plastid sequences of Gaskin and Wilson (2007); the latter often are separated as part of a distinct genus *Pilosella* (Kilian et al. 2009). Among the native species, there was little separation with the exception of the shale barren endemic, *H. traillii* (Fig. 1). The native species of *Lactuca* formed a monophyletic group, within which *L. floridana* and *L. biennis* were clearly distinct, but the remaining species (*L. canadensis*, *L. graminifolia*, and *L. hirsuta*) were basically identical to one another for ITS sequences (Fig. 1). The species of *Lactuca* from North America are all allopolyploids, with $2n = 34$ (Whitaker & Thompson 1941), but there was no evidence of polymorphisms in the ITS sequence data that might help to resolve their ancestry.

The most complex native group of Cichorieae was *Nabalus*, in which there was differentiation for ITS sequences among some species and groups of species, but not all. The overall placement of North American *Nabalus* in a clade well removed phylogenetically from *Prenanthes* supports their separation as distinct genera. Within *Nabalus*, samples of *N. trifoliolatus* formed a clade that was sister to the remaining species in the ML tree (Fig. 1). A group of samples of *N. roanensis* representing material that has been identified as *N. cylindricus* was placed in a clade separate from the other samples of this species, suggesting a reevaluation of its status is needed. Although Cronquist (1980) and Fusiak and Schilling (1984) lumped these two species based on overall morphology, the two can be separated based on stem pubescence (glabrous in *N. cylindricus*, pubescent in *N. roanensis*) and leaf morphology (at least some leaves pinnately 3-5 lobed in *N. cylindricus* vs. dentate in *N. roanensis*). Both *N. cylindricus* and *N. roanensis* occur in montane habitats in the Blue Ridge, and it is unclear if there might be geographic or elevational separation of the two. Samples of *N. roanensis* were placed among a group of species including *N. altissimus*, *N. autumnalis*, and *N. racemosus*, within which there was little differentiation (Fig. 1). The sister clade to this group was formed by samples of *N. albus*, which was only recently documented to occur in the state, where it forms the southern extension in the middle of the range of this species. The ITS sequences of the Tennessee samples of *N. albus* were identical to those sampled from northern areas. The other clade in *Nabalus* was formed by samples of *N. asper*, *N. barbatus*, *N. carrii*, *N.*

crepidineus, and *N. serpentarius*, among which there was little differentiation for ITS sequence (Fig. 1).

The results of BLAST searches in GenBank for members of Cichorieae generally gave a top match and usually almost identical sequence to a conspecific sample, if the species had been sampled. The exception was the GenBank sample labeled *Sonchus arvensis* (AY947407), which based on its placement (Fig. 1) is clearly from a member of *Lactuca*, although its sequence did not match that of any of the species sampled for this study.

The results of molecular phylogenetic analysis of the native genera of Cichorieae add to the diversity of biogeographic patterns observed in Asteraceae of southeastern North America. A general pattern of having basal lineages of genera of Asteraceae found in the extreme southeastern part of North America was noted for *Helianthus* by Schilling et al. (1998). None of the genera of Cichorieae appear to exhibit this pattern. *Krigia* is a derived member of a subtribe that is otherwise found in western North America (Lee et al. 2007), suggesting that its origin is from that region, similar to *Vernonia* and some genera of Senecioneae (Schilling 2013; Schilling & Floden 2014). In contrast, the basal branching members (Fig. 1) of both *Nabalus* and *Hieracium* are species from northeastern North America. The case for *Lactuca* is unclear, in part because of the widespread geographic distribution of its native species, including *L. floridana* which is placed sister to the remainder of the North American species (Fig. 1). The results presented here for the single marker ITS suggest that broader sampling of both taxa and molecular markers is needed to clarify the diversification patterns in genera of Asteraceae from southeastern North America.

ACKNOWLEDGEMENTS

Thanks to S. Robertson and J. Schilling for laboratory assistance, J. May and V. Brown of the University of Tennessee MBRF for help with DNA sequencing, T. Wieboldt (VPI) for a sample of *Hieracium traillii*, and the numerous collectors, notably D. Estes and the late V. McNeilus, who have helped to assemble a broad and useful herbarium at TENN. Financial support provided by the Hesler Fund of the University of Tennessee Herbarium.

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NEW COMBINATIONS IN *SPOROBOLUS* (POACEAE: CHLORIDOIDEAE)

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ABSTRACT

The following four new combinations are made: **Sporobolus borszczowii** (Regel) P.M. Peterson, **Sporobolus borszczowii** subsp. **acuminatus** (Trin.) P.M. Peterson, **Sporobolus borszczowii** subsp. **ambiguus** (Boiss. & Balansa ex Boiss.) P.M. Peterson, and **Sporobolus montevidensis** (Arechav.) P.M. Peterson & Saarela.

Sporobolus R. Br. is a worldwide genus of more than 230 species, nearly equally distributed between the Western and Eastern hemispheres, and is found in tropical to temperate regions throughout the world (Clayton et al. 2006; Peterson et al. 2014a; Simon 2014). A recent molecular phylogeny and subgeneric treatment expanding the circumscription of *Sporobolus* R. Br. was published with a conservation proposal (2332) to incorporate the species of *Calamovilfa* (A. Gray) Hack. ex Scribn. & Southw., *Crypsis* Aiton, *Spartina* Schreb., and *Thellungia* Stapf within *Sporobolus* (Peterson et al. 2014a, b). In Peterson et al. (2014a), *Trachynotia cynosuroides* (L.) Michx. was cited in synonymy twice — mistakenly included as a homotypic synonym of *Sporobolus michauxianus* (Hitchc.) P.M. Peterson & Saarela and correctly included as a homotypic synonym of *Sporobolus cynosuroides* (L.) P.M. Peterson & Saarela. In the same publication (Peterson et al. 2014a), a new combination in *Sporobolus* for *Crypsis borszczowii* Regel was not effectively made, consequently two subspecies were invalid, and an earlier publication [*Sporobolus densiflorus* (E. Fourn.) Vasey] was pointed out by Kanchi Gandhi, which made our combination based on *Spartina densiflorus* Brongn. a later homonym (Peterson et al. 2014a). In order to correct these mistakes we make four new combinations in *Sporobolus*.

SPOROBOLUS BORSZCZOWII (Regel) P.M. Peterson, **comb. nov.** Basionym: *Crypsis borszczowii* Regel, Bull. Soc. Imp. Naturalistes Moscou 41(2): 306. 1868. *Heleochloa borszczowii* (Regel) Roshev. ex B. Fedtsch., Izv. Imp. Bot. Sada Petra Velikago 14 (Suppl. 2): 52. 1914. *Crypsis acuminata* subsp. *borszczowii* (Regel) Kit Tan, Fl. Turkey & E. Aegean Isl. 9: 584. 1985. **TYPE. KAZAKHSTAN.** Deserto Aralo-Caspium, Ust Ürt [now Kazakhstan or adjacent Uzbekistan], 25 Sep 1857, *E. Boreszcow 500* (holotype: LE; isotype: K barcode 000907273 [image!]).

SPOROBOLUS BORSZCZOWII subsp. **ACUMINATUS** (Trin.) P.M. Peterson, **comb. nov. & stat. nov.** Basionym: *Crypsis acuminata* Trin., Neue Entd. 2: 57. 1821. **TYPE. KAZAKHSTAN.** Lower reaches of the Ural River (lectotype [designated by Tsvelev in Federov, Zlaki SSSR, Grasses of the Soviet Union: 647, 1776]: LE TRIN 1523B1!).

SPOROBOLUS BORSZCZOWII subsp. **AMBIGUUS** (Boiss. & Balansa ex Boiss.) P.M. Peterson, **comb. nov.** Basionym: *Heleochloa ambigua* Boiss. & Balansa ex Boiss., Fl. Orient. 5: 477. 1884 *Crypsis ambigua* (Boiss. & Balansa ex Boiss.) Lorch in Bull. Res. Council Israel, Sect. D, Bot. 11: 97. 1962. *Crypsis acuminata* subsp. *ambigua* (Boiss. & Balansa ex Boiss.) Kit Tan, Fl. Turkey & E. Aegean Isl. 9: 584. 1985. **TYPE. TURKEY.** İzmir, Statión de Boudja, près de Smyrne, 150 m, 31 Aug 1866, *B. Balansa 1541* (lectotype [designated by Peterson et al., Taxon 63: 1234. 2014]: W barcode 0027063 [image!]; isolectotype: W barcode 0048400 [image!]).

SPOROBOLUS MONTEVIDENSIS (Arechav.) P.M. Peterson & Saarela, **comb. nov.** Basionym: *Spartina montevidensis* Arechav., Anales Mus. Nac. Montevideo 1(5): 378–380, t. 43. 1896. **TYPE. URUGUAY.** Montevideo, "Vive en las orillas del Río de la Plata, en parajes cenagosos ordinariamente. Florece en los meses de Febrero y Marzo." 1884, *J. Arechaveleta s.n.* (holotype: MVM; isotypes: Real Colegio Alfonso XII [RCAXII] 2425, W barcode 1916-0030779 ex herb. Hackel [image!], WIS barcode 0254293 [image!]).

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ACKNOWLEDGEMENTS

We thank Robert J. Soreng and Gerrit Davidse for help with nomenclatural decisions and Laurence J. Dorr and Robert J. Soreng for suggesting changes to the manuscript.

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 12. EUDICOTS: CAMPANULACEAE TO CUCURBITACEAE

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ABSTRACT

A floristic and natural history account is provided for nine eudicot families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region at the heart of the Sonoran Desert in southwestern Arizona: Campanulaceae, Cannabaceae, Capparaceae, Caprifoliaceae, Caryophyllaceae, Cleomaceae, Crassulaceae, Crossosomataceae, and Cucurbitaceae. This is the twelfth contribution for this flora, published in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium (ARIZ).

This contribution to our flora in southwestern Arizona includes 9 eudicot families, 23 genera, and 25 species: Campanulaceae (2 genera, 2 species); Cannabaceae (2 genera, 3 species); Capparaceae (1 species); Caprifoliaceae (1 species); Caryophyllaceae (6 genera, 6 species); Cleomaceae (2 genera, 2 species); Crassulaceae (3 genera, 3 species); Crossosomataceae (1 species); and Cucurbitaceae (5 genera, 6 species). A synopsis of local distributions and growth forms of the nine families is given in Table 1.

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. These contributions are also posted open access on the website of the University of Arizona Herbarium (ARIZ).

Family designations follow APG III (Angiosperm Phylogeny Group 2009; also see Stevens 2001). Three present-day species, *Celtis pallida, C. reticulata*, and *Crossosoma bigelovii*, also represented by fossil specimens, are indicated with a dagger symbol (†) and *Symphoricarpos*, no longer present in the flora area, is marked with two dagger symbols (††). The two non-native species are marked with double asterisks (**), indicating they are not established in the flora region. In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish,

and the Hia-Ced O'odham dialect, respectively (Spanish-language names are italicized). The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that such quantitative values are, to varying degrees, seldom exact.

Table 1. Local distributions and growth forms of Campanulaceae, Cannabaceae, Capparaceae, Caprifoliaceae, Caryophyllaceae, Cleomaceae, Crassulaceae, Crossosomataceae, and Cucurbitaceae. † = Modern species also represented by a fossil; †† = fossil taxon no longer present; ** = non-native species not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = Summer/warm season ephemerals; WI = winter-spring/cool season ephemerals; AP = facultative annuals or perennials; PR = perennials.

Taxa	Region			Growth Form			
				Ephemerals		Facultative annuals or perennials	Perennials
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter		
CAMPANULACEAE							
Nemacladus orientalis	OP	CP	TA		WI		
Triodanis biflora	OP				WI		
CANNABACEAE							
***Cannabis sativa*	?	?	?	SU			
†*Celtis pallida*	OP	CP					PR
†*Celtis reticulata*	OP						PR
CAPPARACEAE							
Atamisquea emarginata	OP						PR
CAPRIFOLIACEAE							
††*Symphoricarpos* sp.	OP						PR
CARYOPHYLLACEAE							
Achyronychia cooperi	OP	CP	TA		WI		
Cerastium texanum	OP				WI		
Drymaria viscosa		CP			WI		
***Herniaria hirsuta*	OP				WI		
Loeflingia squarrosa	OP	CP	TA		WI		
Silene antirrhina	OP	CP			WI		
CLEOMACEAE							
Polanisia dodecandra	OP			SU			
Wislizenia refracta	OP	CP				AP	
CRASSULACEAE							
Crassula connata	OP	CP	TA		WI		
Dudleya arizonica	OP	CP	TA				PR
Graptopetalum rusbyi	OP						PR
CROSSOSOMATACEAE							
†*Crossosoma bigelovii*	OP	CP	TA				PR
CUCURBITACEAE							
Brandegea bigelovii	OP	CP	TA		W		
Cucurbita digitata	OP	CP	TA				PR
Cucurbita palmata			TA				PR
Echinopepon wrightii	OP			SU			
Marah gilensis	OP						PR
Tumamoca macdougalii	OP						PR

Unless otherwise stated, all photos and scans are by Sue Rutman and all botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986) except for *Tumamoca*. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2014). We have seen specimens or images of all specimen cited. When no collection number is provided, the specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region (Figure 1). Additional explanation of the format for this flora series is provided in part 3 (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

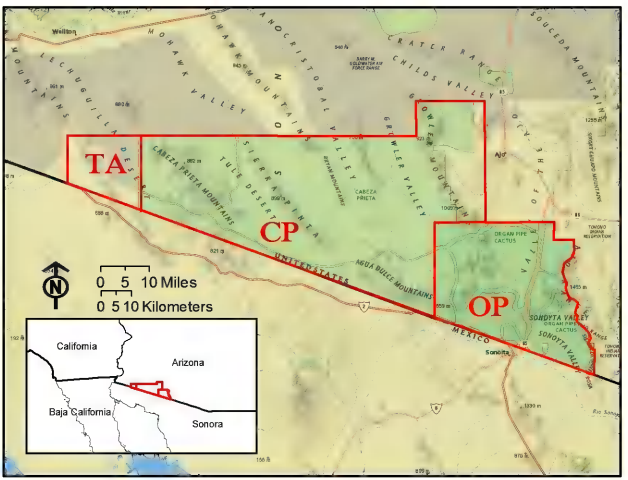

Figure 1. Flora area in southwestern Arizona. TA = Tinajas Altas; CP = Cabeza Prieta NWR; OP = Organ Pipe Cactus National Monument. Green shading indicates approximate boundaries of federally designated wilderness.

CAMPANULACEAE – Bellflower Family

Small cool-season ephemerals (those in the flora area; elsewhere also perennial herbs to trees). Leaves alternate, simple, without stipules. Flowers 5-merous; corollas sympetalous; ovary inferior. Fruit a capsule; seeds numerous and minute. This worldwide family of 84 genera and 2380 species is poorly represented in deserts.

1. Flowering stems branched and zigzag above with minute bracts (not leafy); flowers and fruits stalked; corollas white and red; capsules to 3.5 mm long; widespread in desert habitats. ..... **Nemacladus**

1. Stems straight and unbranched or branching from the base and leafy; flowers and fruits sessile; flowers cleistogamous or the upper (terminal) flowers may have bluish or lavender/purple corollas; capsules 5 mm long; upper edge or above the desert in the Ajo Mts ..... **Triodanis**

Nemacladus

Southwestern USA and northwestern Mexico; 18 species.

Nemacladus orientalis (McVaugh) Morin
[*N. glanduliferus* Jepson var. *orientalis* McVaugh]
Redtip thread plant. Figure 2.

Plants 3.5–18 cm tall, glabrous or sparsely to moderately pubescent at the base. Herbage usually dark olive-green to purple-brown. Stems thread-like, the branches zigzag. Leaves 3–10 mm long in a compact basal rosette, oblanceolate with toothed margins, withering before flowering; stem leaves bract-like or absent. Pedicels slender, longer than the flowers. Corollas bilateral, 1.5–3 mm long, 2-lipped, the upper lip 3-lobed, the lower 2-lobed, the lobes white with reddish-tips.

Widespread; washes, plains, bajadas, canyons, and mountains in Organ Pipe, much of Cabeza Prieta, and locally farther west along Coyote Wash.

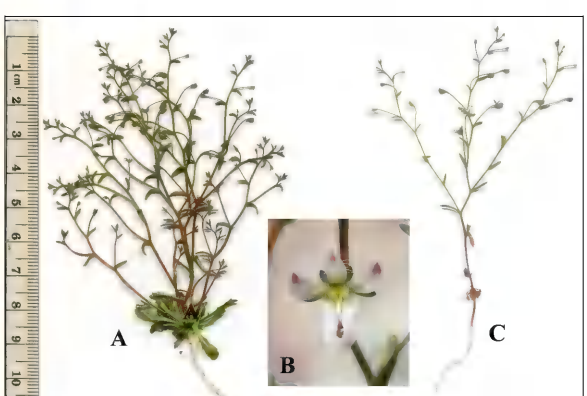

Figure 2. *Nemacladus orientalis*. (A) Hwy 85, sands of small wash N of Crater Range, Maricopa Co., 28 Feb 2015. (B) Growler Canyon, Bates Mts, 20 Mar 2005. (C) Kuakatch Wash near Hwy 85, 28 Feb 2008.

Inland southern California, southern Nevada, southern Utah, Arizona, New Mexico, northern Sonora, and Baja California.

OP: Alamo Canyon, 14 Mar 1941, *Benson 10663*. Quitobaquito, 25 Mar 1944, *Clark 11481*. Bates Well, 17 Mar 1945, *Gould 2978*. Bull Pasture Trail, 5 Apr 1978, *Bowers 1202*.

CP: S end of Sierra Pinta, *Monson 20 Mar 1958*. Tule Well, sandy flat and wash, saline soil, 6 Apr 1979, *Lehto L-23567* (ASU). Charlie Bell Road near E Refuge boundary, 9 Apr 1993, *Felger 93-329*.

TA: Coyote Water, 21 Feb 2005, *Felger 05-147*. Below Raven Tank, deep xeroriparian canyon, 29 Mar 2010, *Felger 10-235*.

Triodanis – Venus looking-glass

North America and Mediterranean Region; 7 species.

Triodanis biflora (Ruiz & Pavón) Greene

[*Triodanis perfoliata* var. *biflora* (Ruiz & Pavón) Bradley]

Small Venus looking-glass. Figure 3.

Delicate ephemerals, the stems 4–40+ cm long, slender and 4-angled, usually straight and unbranched or larger, robust plants sometimes branched from near the base. Leaves or leaf-like bracts alternate. Most or all flowers cleistogamous, especially on smaller and drought-stressed plants, and without petals, and only the uppermost one to several flowers of larger plants may open and bear attractive lavender corollas with a white center. Seeds minute, shiny white, escaping through small pores opening by flaps in the capsule walls.

Figure 3. *Triodanis biflora*. (A) Alamo Canyon, 18 Mar 2005. (B) Nisene-Marks State Park, Santa Cruz Co., CA, 3 Jun 2005, photo © by Aaron Schusteff (CalPhotos).

Ajo Mountains at higher elevations, highly localized. In Bull Pasture it grows at the margins of small ephemeral streams or puddles.

Arizona mostly above the desert. Across much of the USA except the northern portion, and Mexico to South America.

OP: Saddle between Boulder Canyon and Arch Canyon, 3800 ft, 3 May 1978, *Bowers 1285*. Bull Pasture, along ephemeral stream: 3 May 1978, *Bowers 1278* (ORPI); 10 Apr 2005, *Felger 05-200*. Alamo Canyon, S fork, 2650 ft, 25 Apr 2003, *Rutman 2003-511* (ORPI).

CANNABACEAE – Hemp Family

Annuals to trees and some vines. Worldwide, 11 genera, 170 species.

**Cannabis

One species; annual. Native to Central Asia.

Cannabis sativa Linnaeus

Marijuana, dope; *mota*. Figure 4

Marijuana has long been trafficked from Mexico across the flora area, and occasional clandestinely or accidentally seeded plants may be encountered in wet seasons and wetland sites. Human "mules" carry 50-pound backpacks of carefully sealed and weighed bundles of *mota* into the USA and sometimes have small quantities for personal use. Loads have sometimes been abandoned, the packaging degrading over time or being eaten by small mammals, and the marijuana spilling out into the desert. Travelers on Hwy 85 expel their personal use quantities prior to entering Mexico; seedlings might be expected along the southern terminus. Much of the marijuana imported across the USA/Mexico border in Arizona is grown in the Mexican state of Sinaloa. The drug cartels that control the illicit drug trade supply to the USA are responsible for murders and other tragedies as well as political corruption and economic instability in Mexico.

Figure 4. *Cannabis sativa*. Bales of marijuana confiscated in Organ Pipe, ca. 2007.

Celtis – Hackberry

Hardwood trees and shrubs. Leaves alternate, simple, usually with 3 main veins, and scabrous (rough, sandpaper-like when rubbing your finger backwards on the leaf). Flowering with new growth; flowers in small axillary clusters, wind-pollinated, small, and mostly unisexual, the sepals inconspicuous, petals none; male flowers produced first, and sometimes with bisexual flowers between the male and female flowers. Stamens held by the cupped sepals, the filaments expanding

like tension-held springs as they mature, suddenly straightening and flinging a small puff of dry, powdery pollen from the anthers. Fruits of drupes (1-seeded).

Worldwide, mostly tropical and temperate; 60 species.

1. Thorny, spinescent, briar-like shrubs, often with zigzag twigs; fruiting pedicels shorter than the fruits; fruits orange; widespread ..... **Celtis pallida**
1. Unarmed trees or large shrubs usually with a single trunk, the twigs straight (not zigzag); fruiting pedicels as long as or longer than the fruits; fruits reddish; Ajo Mountains ..... **Celtis reticulata**

Celtis pallida Torrey subsp. **pallida**
[*C. tala* Gillies var. *pallida* (Torrey) Planchon]
Desert hackberry; *cimaro, garambullo*; kuavuli. Figure 5.

Spinescent, briar-like shrubs mostly 1.5–3 m tall, the bark smooth; herbage with stiff, appressed white hairs, becoming glabrate with age. Twigs often zigzag, often with single or paired thorns and especially the larger thorns often with 1 (2 or 3) nodes that often produce small leaves and sometimes flowers. Leaves gradually drought deciduous, 2.2–4 (7) cm long, the blades asymmetric at base, more or less ovate to broadly elliptic, scabrous, the margins entire or toothed; petioles short. Flowers in small axillary clusters shorter than the leaves, in March and with summer-fall rains. Fruits 8 mm long, rounded, with a thin, fleshy, orange, and edible pericarp.

Widespread in Arizona Upland areas across Organ Pipe (not in the southwestern portion) and the eastern margin of Cabeza Prieta. Often along larger washes and canyons in mountains on the east side of Organ Pipe. Fossils in Organ Pipe date to 8600 years ago.

Central Arizona to southern Texas and Oaxaca, both Baja California states, southern Florida, Central America, and Paraguay and Argentina. An additional subspecies occurs in South America.

Prominent domatia form in the axils of the major leaf veins near the base of the blade; these are pocket-like flaps of hairs that provide habitat for predatory mites (see Dottori 1976). The domatia of this species are unique and more prominent than on the other *Celtis* from the Sonoran Region, and can be used as a diagnostic feature.

The small, orange, fleshy fruits are slightly sweet and edible when fresh, mostly as a minor resource or snack food on the trail. Castetter and Bell (1951: 207) and Hodgson (2001) interpret Rogers's report (in Castetter & Bell) of "orange-colored" edible fruits as *C. reticulata*, but orange fruits would be from *C. pallida* and not *C. reticulata*, which has hard, reddish-brown fruits.

Based on examination of the type specimen, Berg and Dahlberg (2001) reported that the desert hackberry should be called *C. ehrenbergiana* (Klotzsch) Liebmann. James Henrickson (pers. comm. to Felger, 2012) also looked at the type specimen of *C. ehrenbergiana* and is of the opinion that it more closely fits *C. iguanaea* (Jacquin) Sargent and does not pertain to *C. pallida*. However, *Celtis iguanaea* and *C. pallida* are closely related (Sherman-Broyles 1997).

OP: Pitahaya Canyon, *Nichol 23 Feb 1939* (ORPI). 7.3 mi W of Hwy 85 on S. Puerto Blanco Drive, 10 Nov 1987, *Felger 87-285*. Alamo Canyon, *Wirt 14 Oct 1989* (ORPI). Canyon NW of Kino Peak, 20 Mar 2005, *Rutman 2005-0320-31* (ORPI). †Alamo Canyon, seeds (endocarps), 1150 to 8590 ybp (3 samples). †Puerto Blanco Mts, on ridge, endocarps, 2160 to 7970 ybp (5 samples; not on slopes today but in washes below).

CP: Cameron Tank, *Simmons 22 Sep 1963* (CAB). Charlie Bell Rd, 1 km W of E boundary of Refuge, 5 Mar 1994, *Felger 94-25*.

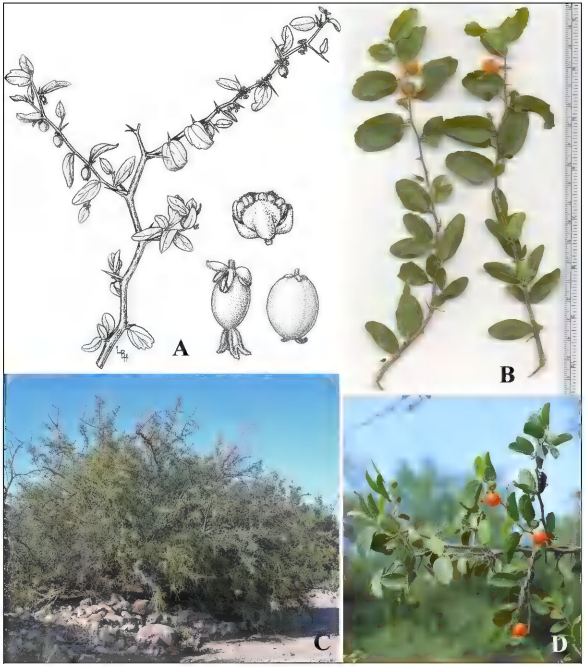

Figure 5. *Celtis pallida* subsp. *pallida*. (A) Spinescent branch, a male flower (above), and a bisexual flower and fruit (below), by Lucretia Breazeale Hamilton. (B) Alamo Canyon, 10 Sep 2008. (C) Kuakatch Wash near Hwy 85, 26 Jan 2009. (D) Gunsight Hills, 10 Sep 2013.

Celtis reticulata Torrey
Netleaf hackberry; *cúmero*. Figure 6

Trees 2.5–7 (12) m tall, with large, well-formed trunks, the trunks and lower limbs studded with rough, woody, knobby ridges. Leaves winter deciduous, highly variable in size, to about 8 cm long, the blades broadly ovate, scabrous, usually rather thick and tough, asymmetric at the base, the margins mostly entire, but at least some leaves often with margins serrated above the middle part of the blade; petioles short. (Rapidly growing long shoots of new growth may have unusually large and

relatively thin leaves, and sometimes with toothed margins extending to the base of the leaf blade; figure 6C). Flowering in spring. Fruits red-brown, hard-walled, ripening in summer.

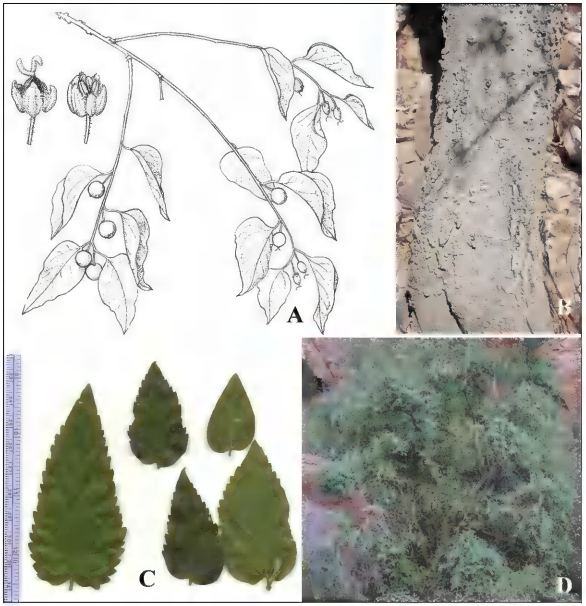

Figure 6. *Celtis reticulata*. (A) Female flower on left, male flower on right, by Lucretia Breazeale Hamilton. South fork of Alamo Canyon: (B) Bark of mature tree, 7 Feb 2013; (C) 9 Sep 2013. (D) Boulder Canyon, 24 Sep 2007.

Riparian canyon bottoms in the Ajo Mountains, including Alamo and Arch Canyons, mostly above 3000 ft; canyons, crevices in bedrock, or against bedrock cliffs on north-facing slopes. In 2003, more than one dozen trees, mostly with well-formed single trunks, were encountered along the bottom of Alamo Canyon, one near the abandoned ranch and the others farther up the canyon growing with oaks (*Quercus turbinella*) and rosewoods (*Vauquelinia californica*). Five of these adult hackberry trees, the largest one about 12 m tall, died in the extreme drought of 2001–2002. By 2010

the remaining trees were either dead or dying. This species has been in Alamo Canyon since at least the early Holocene.

Widespread in southwestern USA to Washington and Kansas, and northern Mexico including Baja California Norte and Sur, Isla Tiburón, and Sonora to Coahuila.

The small fruits are marginally edible, but dried and crushed they impart a pleasant flavor to beverages and food.

OP: Alamo Canyon: 13 Sep 1941, *Goodding 303-41*; 29 Mar 2003, *Felger 03-394*. Arch Canyon, beneath arch, one tree 8 ft tall, *Rutman 26 Sep 2002* (ORPI). †Alamo Canyon, seeds (bony endocarp), 1150 & 9570 ybp.

CAPPARACEAE – Caper Family

Trees, shrubs, vines, and herbs. Worldwide, especially in the tropics; 16 genera, 480 species.

Atamisquea

This genus has a single species. *Atamisquea* and many members of the caper family are strong or foul smelling with watery sap containing mustard-oil glucosides.

Atamisquea emarginata Miers ex Hooker & Arnott
[*Capparis atamisquea* Kuntze]
Palo hediondo. Figure 7.

Much-branched, hardwood shrubs often 2–2.5 m tall, sometimes to 4 m with several trunks, each 12–15 cm in diameter. Sue Rutman (5 May 2005) observed clonal propagation by root sprouts at Quitobaquito. Twigs straight, stout, rigid, and brittle, often branching at right angles, often bluntly thorn-tipped, otherwise unarmed. Young stems, lower leaf surfaces, outer surfaces of sepals, and pistils and fruits densely covered with translucent, winged silvery to yellowish peltate scales. Leaves evergreen or eventually leafless in extreme drought, alternate, simple, thick, and leathery, (0.8) 1–3 cm long on short shoots, or often 2.5–5.5 cm long on long shoots. Petioles stout, 1–2 mm long, the leaf blades linear-oblong to oblong, dark green above, dull silvery to brownish below with a dense cover of scales, the midrib prominent; leaf margins entire or the tip sometimes moderately notched; stipules none.

Flowers solitary to few in leaf axils. Flowers moderately bilateral. Sepals 4, essentially separate, green, the outer pair cupped and much larger and thicker than the inner pair. Petals and stamens cream-white; petals 4 (6) in number, often 6.5 mm long. Fertile stamens 6 (7), the filaments often 5.5 mm long, plus 0–3 staminodes. Ovary green beneath the scales. Body of fruit 8–11.3 × 6–7.7 mm, oval with a small, pointed tip, olive-green below the dense, silvery scales. Ripe exocarp splitting to reveal a bright red, fleshy aril, giving the ripe fruits a spongy texture. Exocarp and aril with a strong, spicy odor like creosotebush and a sharp horseradish taste. Seeds 1 (2 or rarely 3) per fruit, 3.8–5 × 3.2–4.3 mm, nearly orbicular to broadly kidney-shaped, firmly embedded in the aril and blackish when cleaned. Flowering profusely in May and June. Fruits ripening simultaneously in August.

Flowers visited by honeybees, native bees, large tarantula-hawk wasps (*Hemipepsis* sp.), and many other insects. The red arils and seeds are eaten by birds including the house finch and verdin, which are likely seed dispersers. *Atamisquea* is the only larval food for the pierid butterfly *Ganyra* (*Ascia*) *howarthi* (Bailowitz 1988).

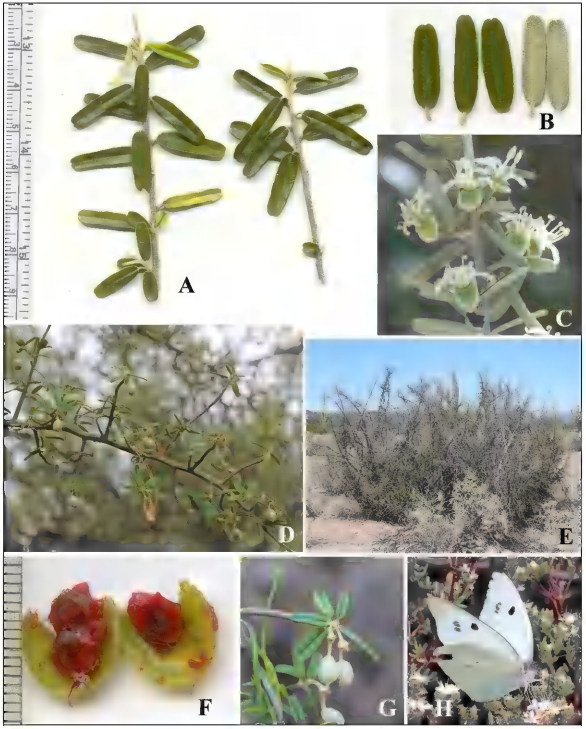

Figure 7. *Atamisquea emarginata*. Quitobaquito: (A & B) 5 Apr 2013; (C) 7 Jun 2005. (D, F & G) Aguajita Wash near USA/Mexico boundary, 2 Aug 2014. (E) Drought-stricken plant, eastern tributary of Aguajita Wash near USA/Mexico boundary, 12 Oct 2006. (H) Female Howarth's white, *Ganyra howarthi*, on *Frankenia palmeri*, near Bahía Kino, Sonora, 30 Mar 2009, photo © by Dave Powell.

Shrubs, mostly to 2 m tall, are common on sandy gravelly flats immediately east of Aguajita Spring, and a few, scattered, shrubs occur northward to 6 km from Aguajita Spring. Also shrubs or

small trees to 4 m tall with several trunks, as well as small plants, were infrequent in the dense mesquite thicket near Aguajita Spring in the immediate vicinity of the international fence. Large *Atamisquea* shrubs also grow in dense brush south and north of the Quitobaquito pond.

No other plants of this species are known from the USA, although it is common along old floodplains of the nearby Río Sonoyta in Sonora and southward in western Sonora to coastal northwest Sinaloa. Also on the Baja California Peninsula and disjunct in South America.

OP: Quitobaquito: 27 Nov 1939, *Harbison 26181* (ARIZ, SD); Old fields, two shrubs, climbing into mesquite, 3.6 & 4 m tall, 6 Apr 1988, *Felger 88-310*. 1 mi NE of Quitobaquito Springs, 23 Aug 1975, *Engard 784* (DES). 4 mi N of Quitobaquito, one shrub, 3+ m wide and 2 m tall, 7 Jun 1975, *Engard 543* (DES). Aguajita Spring, 13 Jun 1978, *Bowers 1335*. 350 m E of Aguajita Wash, *Atriplex* flat, 13 May 1988, *Baker 7612* (ASU). Several plants growing to the S of Quitobaquito Pond, in an old-growth *Prosopis velutina-Ziziphus obtusifolia* bosque, *Atamisquea* is clonal, *Rutman 5 May 2005*. La Abra Plain, 2 mi W of Ten-Mile Hill and ¾ mi E of Aguajita Wash, via South Puerto Blanco Drive, sparse xeroriparian zone through hypersaline area dominated by *Atriplex polycarpa*, N of South Puerto Blanco Drive, several more plants along same riparian system to the S of South Puerto Blanco Drive; single large shrub that died back due to prolonged drought of the early 2000s now seems to be recovering, 12 Oct 2006, *Rutman 20061012-6*. Wetland/bosque N of Quitobaquito Pond, *Tibbitts 13 May* 2013.

CAPRIFOLIACEAE – Honeysuckle Family

Worldwide, especially the Northern Hemisphere; 42 genera, 890 species.

Symphoricarpos

This genus includes about 15 species, mostly in temperate regions of North and Central America, and 1 species in China.

††Symphoricarpos sp.

Snowberry

Winter deciduous shrubs. Fruits fleshy, globose, and white.

It was in the Ajo Mountains from 13,500 to 32,000 years ago. The nearest present-day population of this genus is *S. longiflorus* A. Gray in pine-oak woodland on Baboquivari Peak (7 Oct 1944, *Gould & Haskell 2765*; also see Kearney & Peebles 1960).

OP: †Alamo Canyon, seeds, 14,500, 29,110, & 32,000 ybp. Montezuma's Head, seeds, 13,500 & 20,490 ybp.

CARYOPHYLLACEAE – Pink Family

The five species in the flora area are winter-spring ephemerals (other members of this family are often perennial herbs, vines, or shrubs). Leaves opposite (see *Drymaria*) or sometimes alternate, simple, entire. Flowers usually bisexual and radial; sepals 4 or 5, separate or united; petals 4 or 5, separate, the apex often notched (bilobed) or deeply cut (fringed), or petals sometimes reduced or absent. Fruit a capsule, the seeds few to numerous or sometimes a 1-seeded utricle.

Worldwide; 86 genera, 2200 species.

1. Plants densely and conspicuously glandular hairy.

2. Plants spreading to prostrate, usually more than 6 cm wide and more than 3 cm tall; stems clearly visible, the leaves not rigid..... **Drymaria**

2. Plants very compact, dwarf and mat-like, usually less than 6 cm wide and less than 2.5 cm tall; stems at least partially obscured by needle-like rigid leaves…… **Loeflingia**

1. Plants not glandular hairy, or sometimes sparsely glandular pubescent or with patches of glands.

3. Plants glabrous; stipules conspicuous, papery and white; petals absent…… **Achyronychia**
3. Plants sparsely hairy; without stipules; petals present.

4. Stems weak and sprawling, without glandular patches; sepals separate; petals white …… **Cerastium**
4. Stems erect to ascending, with conspicuous glandular patches; sepals united most of their length; petals red-purple…….... **Silene**

Achyronychia

This genus has a single species.

Achyronychia cooperi Torrey & A. Gray
Sandmat, frostmat. Figure 8.

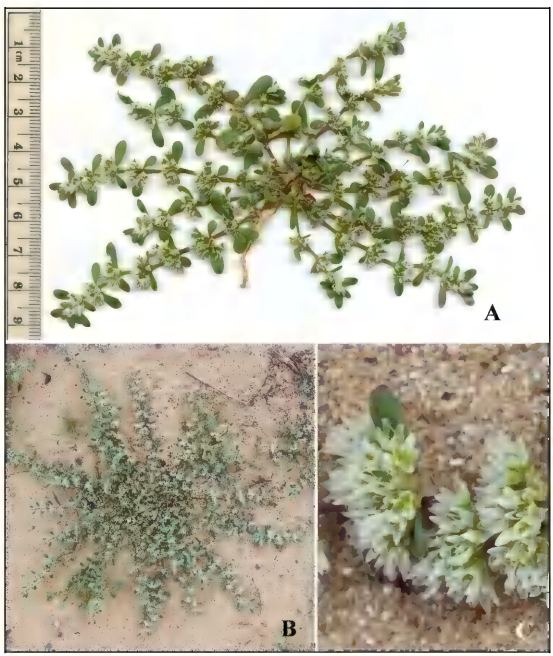

Figure 8. *Achyronychia cooperi*. (A) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 18 Feb 2015. (B & C) Dunes near airport, N of Mex Hwy 37 about 25 miles E of Puerto Peñasco, Sonora, 20 Feb 2015.

Small winter-spring ephemerals, glabrous, becoming prostrate and mat-like. Leaves opposite, bright green, spatulate (widest at tip), those of each pair unequal in size; stipules thin, papery white, and conspicuous. Flowers small, crowded in axils along the stem, the calyx lobes with conspicuous papery, white wings resembling the stipules; petals none. Fruits 1-seeded, indehiscent.

Widespread, mostly on sandy soils in valley bottoms, washes, and dunes, especially in the western part of Cabeza Prieta and the Tinajas Altas Region, and widely scattered elsewhere in the lowland desert in the flora area.

Deserts in western Arizona, Nevada, California, Sonora, and both Baja California states.

OP: Foothills of the Growler Mts, 16 Apr 1952, *Parker 7984*. Flats W of Bates Mts, 31 Mar 1978, *Bowers 1162* (ORPI).
CP: Papago Well, 13 Mar 1983, *Eiber 23*. Salazaria Wash, 12 Apr 1992, *Harlan 209*. Pinta Sands, 11 Jan 2002, *Felger 02-17*.
TA: 1 mi N of Tinajas Altas Pass, W side of mts, *Van Devender 26 Mar 1983*. Coyote Water, 25 Oct 2004, *Felger 04-22*.

Cerastium

Annual and perennial herbs. Worldwide, mostly in north-temperate regions; 100 species.

Cerastium texanum Britton
Mouse-ear chickweed. Figure 9.

Stems delicate, slender, and lax. Leaves often to 3 cm long, thin and broadly spatulate. Inflorescences slender and mostly few-branched with long internodes. Flowers small, the sepals glandular pubescent, the petals white, 5–8 mm long and notched. Capsules cylindrical; seeds many.

Figure 9. *Cerastium texanum*. Alamo Canyon: (A) 12 Mar 2005; (B) 26 Feb 2014; (C) 31 Mar 2008.

Among rocks in shaded places; Ajo and Diablo mountains, especially at higher elevations.

Southern Arizona, New Mexico, and northwestern Mexico at least to southeastern Sonora, southwestern Chihuahua, and in Baja California Sur.

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939* (ORPI). Canyon Diablo, 15 Apr 1951, *Supernaugh 428* (ORPI). Bull Pasture Trail, 11 Apr 1978, *Bowers 1231* (ORPI). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-270*.

Drymaria

Annual and perennial herbs. Widespread in the Americas and introduced elsewhere; 48 species.

Drymaria viscosa S. Watson

Sticky drymary. Figure 10.

Small spring ephemerals, with a well-developed taproot. Plants often partially buried by drifting sand. Stems, leaves, pedicels, and sepals with stalked glandular hairs, with sand grains sticking to the glandular-sticky surfaces. Stems 3–17 cm long, delicate and very slender. Leaves appearing whorled at least from all but the uppermost nodes, semi-succulent, linear-spatulate, tapering basally to the clasping petiole, mostly 5–10 (22) × less than 1–1.5 mm, the first leaves in a basal rosette and larger than the stem leaves; stipules 0.5–1.5 mm long, transparent-membranous, slender, and soon deciduous (or perhaps sometimes absent rather than deciduous). Inflorescences terminal and axillary, short with 4–7 crowded flowers. Flowers minute, white, closing with midday heat; sepals separate, ovate, green in the middle with broad white margins; petals delicate, pure white, Y-shaped with a long, slender claw and an expanded bifid blade. Seeds 0.5–0.7 mm long including the projecting radicle (seen as a strange little projection of the embryo), often 8–12 per capsule. The seeds, resembling grains of sand, are striking compared with seeds of other *Drymaria* species because they are smooth and pale cream or buff instead of sculptured and dark brown.

In the USA known only from the Pinta Sands. Common in similar habitat in adjacent northwestern Sonora southward to the vicinity of Tastiota, 28°20'N, and both Baja California states.

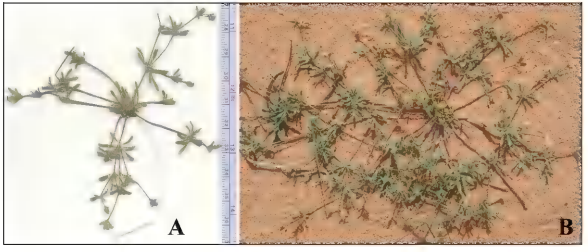

Figure 10. *Drymaria viscosa*. (A) Dunes about 20 mi SW of Sonoyta, near Mex Hwy 8, Sonora, 15 Feb 2014. (B) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 20 Feb 2005.

CP: Pinacate lava flow, E edge, off Camino del Diablo, dunes, 17 Apr 1983, *Hodgson 2080* (DES). West Pinta Sands, 11 Jan 2002, *Felger 02-24* (ARIZ, ASU).

***Herniaria**

Annual, biennial, or perennial herbs. Native in South America, Eurasia, and Africa; 45 species.

****Herniaria hirsuta** Linnaeus var. **cinerea** (de Candolle) Loret & Barrandon
Burst-wort. Figure 11.

Cool season ephemerals; the plants small and prostrate. Leaves 1–12 mm long, oblanceolate to obovate, opposite below, alternate above. Flowers axillary, minute and inconspicuous.

Figure 11. *Herniaria hirsuta* var. *cinerea*. Midway Wash near Hwy 85 at mile marker 28, 7 Mar 2015.

Occasional in Organ Pipe in disturbed habitats, probably not established.

Naturalized in disturbed habitats in the Sonoran Desert National Monument and the Goldwater Range (Felger et al. 2007). A widespread weed, native to Eurasia and North Africa.

OP: Organ Pipe headquarters, wet ground of water drain, several dozen plants, 11Mar 2003, *Felger 03-246*.

Loeflingia

Annuals. North America, Eurasia, and Africa; 7 species.

Loeflingia squarrosa Nuttall
[*L. squarrosa* subsp. *cactorum* Barneby & Twisselmann]
Spreading pygmy-leaf. Figure 12.

Dwarf spring ephemerals, glandular pubescent, quickly forming a taproot and dense, cushion-like mats usually less than 1.5 cm tall and about 1 (5) cm wide, and sometimes as small as 3 × 3 mm.

Leaves often 3–15 mm long, reduced upwards, narrowly linear, mostly stiff and thickened (subulate), with a short bristle tip; first leaves often in a loose basal rosette, thin, and soon withering; stipules white, bristle-like. Flowers essentially sessile; cleistogamous, minute and hidden among the leaves, sepals resembling the leaves. Seeds numerous, 0.4–0.45 mm long.

Widespread in lowlands across the flora area, often on open, partially barren gravelly-sandy soils, such as decomposed granite pediments or upper bajada flats or washes, or sandy plains and washes, and sometimes among dense spring ephemerals in microhabitats where water temporarily had puddled.

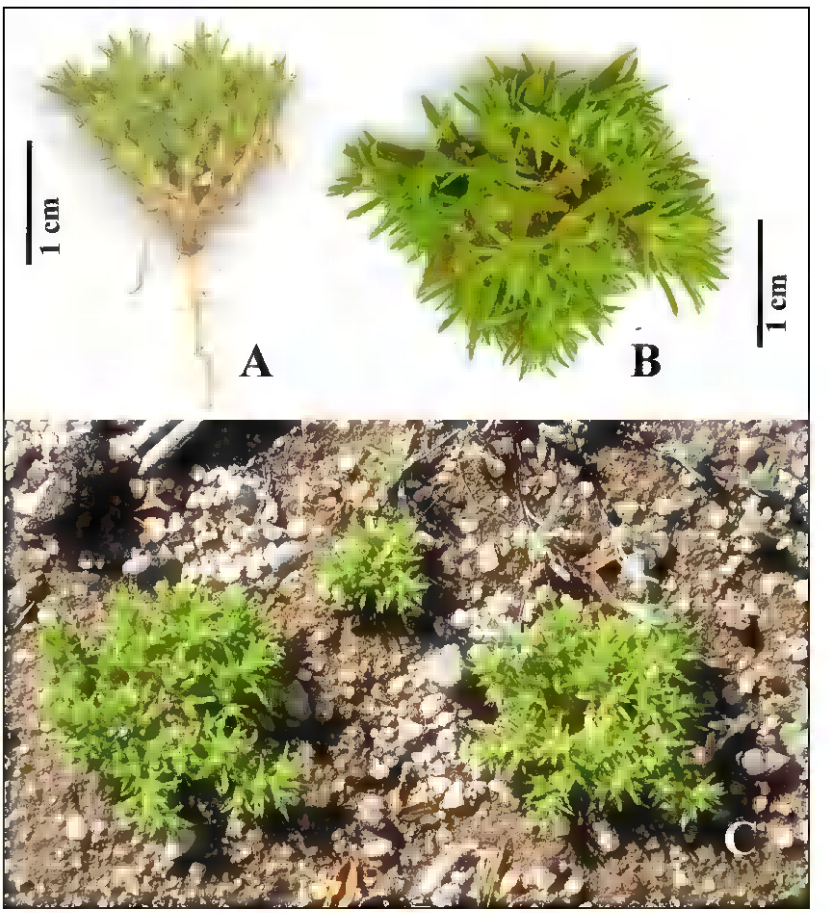

Figure 12. *Loeflingia squarrosa*. W of mile marker 60, Hwy 85: (A) 21 Mar 2003; (B) 19 Dec 2008; (C) 13 Feb 2005.

Western USA and northern Mexico.

OP: Senita Basin, small wash, 24 Mar 1979, *Lehto 23386* (ASU). Armenta Rd, 11 Mar 2003, *Felger 03-184*. W of Bates Well Road near Growler Pass, 7 Mar 2003, *Rutman 2003-227* (ORPI). SW base of Santa Rosa Mts, 12 Mar 2003, *Felger 03-355*.

CP: Cholla Pass, S22, T15S, R9W, 5 Apr 1979, *Lehto 23467* (ASU). Flats near Sheep Mt, N end of Agua Dulce Mts, 18 Feb 1979, *McLaughlin 1951*. Lower bajada of NE Growler Mts, 22 Mar 2003, *Rutman 2003-375*.

TA: Tinajas Altas, 15 Jun 1992, *Felger 92-608*.

Silene – Campion, catchfly

Annual to perennial herbs. Mostly in the Northern Hemisphere; 700 species.

Silene antirrhina Linnaeus

Sleepy catchfly. Figure 13.

Stems to 60 cm with ascending branches, often much smaller, with reddish purple, glandular-sticky bands below the nodes trapping insects and seeds that have fallen from the capsules. Early leaves in a basal rosette, stem leaves narrowly oblanceolate, 2–5 cm × 4–8 mm, the upper leaves reduced; stipules none. Flowers dark red-purple, the petals narrowed basally to a claw. Seeds kidney-shaped, 0.6–0.8 mm in diameter.

Figure 13. *Silene antirrhina*. (A) Alamo Well, 21 Mar 2008. (B) Estes Canyon, 26 Feb 2005. (C) Coffeepot Mountain, Sauceda Mts, 27 Feb 2005. (D) Aphids trapped on glandular area of stem, Hat Mountain, Sauceda Mts, Maricopa Co., 22 Mar 2014.

Widespread in Organ Pipe and on the east side of Cabeza Prieta; sandy soils, often in washes, canyons, and rocky slopes.

Abundant and often weedy across much of North America to nearly 3000 m elevation.

OP: Sweetwater Pass, *Dakan 12 Feb 1973* (ORPI). Arch Canyon, 5 Apr 1978, *Bowers 1193* (ORPI). Kuakatch Wash near milepost 59 on Hwy 85, *Rutman 2 Apr 1998* (ORPI). Below Cement Tank, foothills of Santa Rosa Mts, 2 Apr 2003, *Rutman 2003-445* (ORPI). 1.2 mi NW of Kino Peak, tributary to Growler Wash, draining NW slopes of Kino Peak, 1509 ft, coarse-sandy wash bed, 20 Mar 2005, *Rutman 20050320-25*.

CP: Near Tule Well, 20 Mar 1992, *Yeatts 3236* (CAB). 0.4 mi on Charlie Bell Rd, W of Refuge boundary, 9 Apr 1993, *Felger 93-330*. Daniels Arroyo at Charlie Bell Rd, 9 Apr 1993, *Felger 93-363*.

CLEOMACEAE – Cleome Family

Ephemerals to sometimes perennials (or shrubs elsewhere). Leaves alternate, palmately compound, sometimes unifoliolate. Flowers in racemes. Sepals and petals separate and 4 each. Stamens exserted. Fruit a capsule or with a pair of nutlets.

Mostly tropical and warm temperate regions worldwide, especially in the Americas; 17 genera, 150 species.

1. Plants conspicuously glandular-viscid (sticky); flowers white and reddish; fruits longer than wide. ..... **Polanisia**
1. Plants glabrate, not glandular-sticky; flowers yellow; fruits wider than long..... **Wislizenia**

Polanisia

Annuals or perennials. North America; 5 species.

Polanisia dodecandra (Linnaeus) de Candolle subsp. **trachysperma** (Torrey & A. Gray) H.H. Iltis [*P. trachysperma* Torrey & A. Gray]
Western clammy-weed. Figure 14.

Figure 14. *Polanisia dodecandra* subsp. *trachysperma*. Alamo Canyon: (A) 10 Sep 2008; (B & C) 30 Jul 2013; (D) persistent dead plant, 2 Nov 2013.

Summer ephemerals, glandular and with stalked glandular hairs. Leaves with 3 leaflets. Flowers in long racemes held above the foliage; petals white, to 1 cm long; stamens prominent, reddish purple, 10 or more, to more than twice as long as the petals. Capsules 4+ cm long, many-seeded.

In the flora area, known from a few records in Organ Pipe along drainages from the Ajo and Diablo mountains.

This subspecies is native mainly in the Great Plains and western states and adventive elsewhere. *Polanisia dodecandra*, with 3 subspecies, is widespread in North America from Mexico to Canada, and adventive elsewhere (Tucker & Vanderpool 2010).

OP: Alamo Wash under Hwy 85 bridge, *Rutman 23 Nov 1994* (ORPI). Alamo Canyon, wash bed near springhouse, *Rutman 5 Sep 1999* (ORPI). Drainage W of the Diablo Mts near Hwy 85, 3 Sep 2014, *Rutman*, observation.

Wislizenia

This genus has 3 taxa, variously treated as 3 species (Tucker & Vanderpool 2010) or 3 subspecies.

Wislizenia refracta Engelmann subsp. **refracta**

Jackass clover. Figure 15.

Non-seasonal ephemerals and sometimes persisting as short-lived perennials, the plants glabrate and stinky. Leaves with 3 broadly obovate leaflets. Racemes densely flowered, the flowers bright yellow, bilateral; flowering at almost any time of year, often during dry seasons when few other plants are blooming. Ovary with a slender, elongated, pedicel-like stipe longer than the petals. Stamens 6, longer than the petals. Fruits of 2 divergent 1-seeded nutlets, each 1.8–2 mm long.

Most often in moist, alkaline, sandy soils in washes and along roadsides and rocky granitic slopes at Aguajita and Quitobaquito and other alkaline soils of the La Abra plain east of Quitobaquito, and the extreme southeastern corner of Cabeza Prieta. It is an early pioneer on disturbed alkaline soils. After the 3-acre fire at Hocker Well in 1993, *W. refracta* colonized a de-vegetated area and was soon replaced by *Suaeda nigra* (Rutman, observations 1994–2003).

Subspecies *refracta* occurs in Nevada and southeastern California to New Mexico and western Texas, and northern Sonora and northern Chihuahua. Two other subspecies occur from southeastern California to Baja California Sur and western Sonora. Plants of subsp. *palmeri* (A. Gray) S. Keller in northwestern Sonora are often shrubs (Felger 2000).

Kirk (1970) and Whiting (1939) report that the leaves of young plants can be cooked as greens.

OP: Quitobaquito: 5 Mar 1940, *Peebles 14558*; 18 Feb 1978, *Fay 742*. 9.9 mi E of Quitobaquito on Puerto Blanco Drive, *Van Devender 31 Aug 1978*.

CP: Corner Well (Simmons 1966).

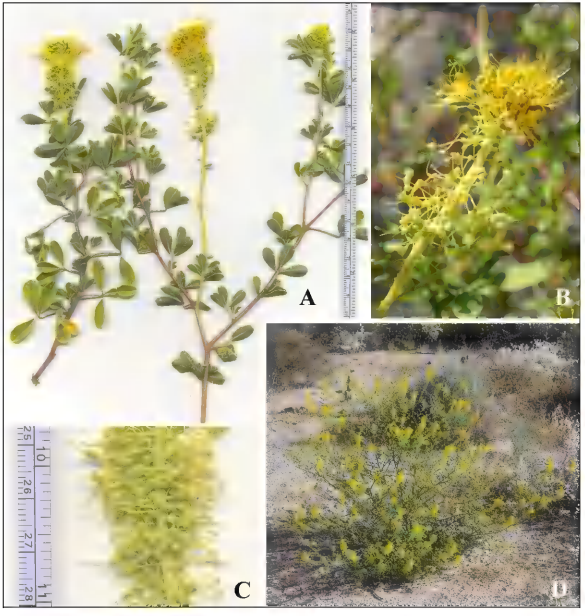

Figure 15. *Wislizenia refracta* subsp. *refracta*. Quitobaquito: (A) 11 Sep 2008; (B) 13 Sep 2006; (C) 6 Oct 2013; (D) 7 Nov 2012.

CRASSULACEAE – Stonecrop Family

Succulent ephemeral and perennial herbs, mostly glabrous (elsewhere also shrubs). Leaves alternate or opposite. Flowers radial, 3–5-merous. Sepals and petals often separate, or sometimes united at base or to above middle. Ovary usually superior with 4 or 5 carpels separate or united only at base. Seeds very small.

Nearly worldwide; 34 genera, 1400 species.

1. Minute winter-spring ephemerals; leaves opposite, less than 5 mm long..... **Crassula**
1. Thick-stemmed perennials; leaves alternate in a rosette, 2 or more cm long.

2. Leaves glaucous, often powdery white and more than 5 cm long; flowers tubular, yellow and red, not spotted or cross-banded..... **Dudleya**

2. Leaves glabrous, green or greenish brown, 2–5 cm long; flowers open, cream and reddish spotted and cross-banded..... **Graptopetalum**

Crassula

Annuals and mostly succulent perennials and some shrubs; nearly worldwide, 250 species, especially diverse in southern Africa. The New World species are small annuals.

Crassula connata (Ruiz & Pavón) A. Berger
[*C. connata* var. *eremica* (Jepson) Bywater & Wickens. *Tillaea erecta* Hooker & Arnott]
Pygmy stonecrop; sand pygmyweed. Figure 16.

Diminutive winter-spring ephemerals, (0.5) 1–5.5+ cm tall, succulent throughout; individual plants green, reddish, or yellow-green (different colored plants often intermixed). Leaves opposite, united at base, very fleshy, ovate to oblong and mostly bead-like, the larger ones mostly 2–3.5 mm long. Most or all flowers on a plant sessile or subsessile, some with a minority of flowers on pedicels to 3 mm long (pedicel length seems to be influenced by soil moisture). Flowers (3) 4 (5)-merous, 1 mm wide; sepals (1.2) 1.4–1.6 mm long and longer than the carpels. Corollas white to nearly transparent, shorter than the sepals, the segments lanceolate. Seeds 0.35 mm long, brown, ellipsoid, shiny with faint longitudinal lines (longitudinally ridged when viewed with a scanning electron microscope).

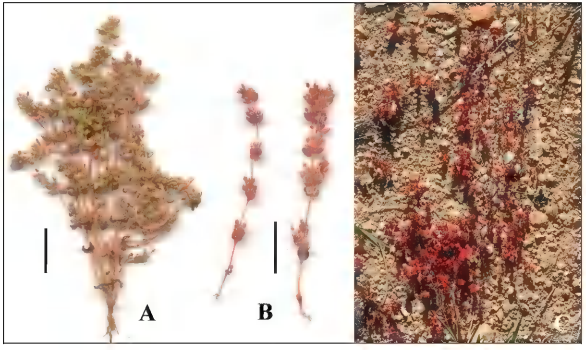

Figure 16. *Crassula connata*. (A & B) Valley of the Ajo, W of Hwy 85 milemarker 60, 22 Mar 2003, scale bar = 1 cm. (C) Javelina Mountain, Sand Tank Mts, 3 Mar 2005.

Seasonally widespread across the flora area, mostly on sandy and gravelly soils, sometimes especially abundant on bajada slopes and broad washes, and also soil pockets on hills and mountains; generally not appearing during drier years.

Western North America to Argentina and Chile in many habitats. Bywater and Wickens (1984) recognized five varieties, although Moran (1992, 1994, 2009) found the varieties to have little geographic meaning and be poorly defined.

OP: Senita Basin, 19 Jan 1973, *Schmitt 3168* (ORPI). 9 mi on 2-way Puerto Blanco Drive E of Hwy 85, 26 Feb 1978, *Bowers 1077* (ORPI). Aguajita Wash, 3 Mar 1992, *Felger 92-105*. Santa Rosa Mts, 12 Mar 2003, *Felger 03-356*. Growler Valley, 11 Apr 2003, *Rutman 2003-460* (ORPI). Bull Pasture, 10 Apr 2005, *Felger* (observation).

CP: Pinacate lava flow, depressions with silt, 7 Apr 1979, *Lehto L23590* (ASU). Charlie Bell Pass, 3 Apr 1992, *Whipple 3946*. Below Heart Tank, 27 Feb 1993, *Felger 93-162*. Papago Well, 26 Feb 1993, *Felger 93-130*.

TA: Camino del Diablo, SSE of Raven Butte, 20 Feb 2005, *Felger 05-26*.

Dudleya

Perennial herbs with succulent leaves. Southwest USA and northwest Mexico. This genus with more than 45 species primarily occurs along the Pacific Coast of California and Baja California, and only two species occur east of California. Members of this genus respond to winter-spring Pacific rains and are summer dormant.

The fresh leaves and young flowering stems of California species, including *D. pulverulenta*, were eaten in spring when the plants are fresh and growing (Bean & Saubel 1972; Meigs 1939; Palmer 1878).

Dudleya arizonica Rose

[*D. pulverulenta* (Nuttall) Britton & Rose subsp. *arizonica* (Rose) Moran. *Echeveria arizonica* (Rose) Kearney & Peebles]

Arizona liveforever. Figure 17.

Perennials growing during the cooler seasons; summer dormant. Leaves in rosettes, the rosettes 1 to several from a short, thick stem and thickened root, the old dry leaves persistent. Leaves several or more per rosette, mostly 4–10.5 cm long, lanceolate to ovate, very thick and succulent, with a white-waxy bloom, whiter during dry periods, greener during winter-spring wet periods, the leaves sometimes reddish. In late spring and early summer the larger leaves dry up and the remaining leaves shrivel and curl in over the center of the rosette. During years of exceptional cool-season rains the Ajo Mountain plants can become unusually large, some leaves reaching 25 cm long and 6 cm wide, and whitish towards base and otherwise rose-colored. Buds and developing inflorescences conspicuously glaucous-whitish; flowering stems and leaves, bracts, and pedicels usually coral pink at anthesis. Flowering stems axillary, usually 1–3+ per rosette, 9–30 (50) cm long, with reduced leaves shriveling as the flowers develop. Flowers 5-merous, 13–16 mm long. Calyx fleshy, greenish glaucous or sometimes coral pink above. Corollas often 13–14 mm long, nearly tubular, reddish orange, or greenish yellow to yellow at base, and yellow-orange to red-orange at the tip. Stamens 10, the anthers red prior to pollen shedding. Capsules 7.5–12 mm long. Seeds many, 0.7 mm long. Flowering March and early April; seeds ripe in May.

Mostly on bedrock slopes and cliffs, often on north-facing slopes, growing wedged between rock crevices. Ajo and Diablo mountains in Organ Pipe and in Cabeza Prieta, Tinajas Altas, and adjacent northwestern Sonora on granitic mountains to peak elevations. Notably prominent on the Mount Ajo trail 2775–4000 feet.

Western Arizona, northwestern Sonora, southern Nevada, southwestern Utah, southeastern California, and northern Baja California.

OP: Canyon Diablo, *Steenbergh & West 25 Apr 1962* (ORPI). Bull Pasture Trail, 3000 ft, 2 May 1978, *Bowers 1268* (ORPI). Plants unusually large, largest leaves 24–25 cm long, thick and succulent, reddish rose and whitish glaucous basally, inflorescence branches and bracts succulent, corollas orange distally, common among rocks, 9 Apr 2005, *Felger 05-173* (ARIZ, ASU, ORPI).

CP: Cabeza Prieta Peak: W slope, *Simmons 27 Oct 1962*; Hanging in crevices of steep, broken cliffs on S face below summit, 2200 ft, common above this elevation to summit, 24 Mar 1995, *Yeatts 3670* (CAB).
TA: Tinajas Altas, *Vorhies 16 Apr 1924*. 1 mi N of Tinajas Altas, 17 Apr 1948, *Kurtz 1170*.

Figure 17. *Dudleya arizonica*. Bull Pasture Trail: (A) 10 Apr 2005; (D) 18 Mar 2005. (B) South Fork of Alamo Canyon, 12 Mar 2005. (C) Crest of Little Ajo Mts, 2 Feb 2004.

Graptopetalum

Succulents perennials. This genus, with about 15 species in Mexico and Arizona, is allied to several genera of diverse Mexican montane succulents such as *Echeveria* attuned to summer-monsoon rains. *Graptopetalum* is the only one to enter the margins of the Sonoran Desert. Two species occur in Arizona; *G. bartramii* Rose occurs above the desert in southeastern Arizona, Chihuahua, and Sonora.

Graptopetalum rusbyi (Greene) Rose
Figure 18.

Perennials with a rosette of succulent leaves, actively growing in spring and with summer-fall rains. Leaves mostly 2–5 cm long, green to greenish brown, oblanceolate. Flowering April and May, flowering stems slender and often 5–15 cm long. Flowers probably 15–20 mm wide, petals cream-colored and banded and spotted with dark red-brown; Moran (1993) euphemistically calls the fragrance "musky." Fruits many-seeded.

Figure 18. *Graptopetalum rusbyi*. (A) Bull Pasture Trail, 18 Mar 2005. (B & C) Lower Jacobson Canyon, Pinaleño Mts, Graham Co., 5 May 2008, photos by Patrick Alexander.

Ajo Mountains, mostly at mid-elevations, often in rock crevices and on shaded or north-facing slopes, canyon walls, and cliffs.

Mountains eastward to central Arizona and Sonora, generally at elevations above the desert; also mountains in Chihuahua and Sinaloa.

OP: Canyon N of Alamo Canyon, 3000–3800 ft, 31 Mar 1948, *Darrow 3863*. Boulder Canyon, *Steenbergh 24 May 1962* (ORPI). Bull Pasture Trail, 3000 ft, 2 May 1979, *Bowers 1269* (ORPI).

CROSSOSOMATACEAE – Crossosoma Family

Shrubs. Southwestern USA and Mexico; 4 genera, 12 species.

Crossosoma

Shrubs. Southwestern USA and Mexico; 2 species.

Crossosoma bigelovii S. Watson

Ragged rock-flower. Figure 19.

Shrubs mostly 1–1.5 m tall, with long and short shoots, the short shoots sometimes becoming long shoots. Leaves alternate on long shoots, clustered on short shoots, evergreen or tardily drought deciduous, mostly 7–15 (21) mm long, elliptic to oblong or obovate, somewhat thick, grayish or glaucous green, subsessile with petioles less than 1 mm long, the margins entire. Flowers fragrant, solitary or in small clusters, bisexual or some of them unisexual, radial, and perigynous, the hypanthium forming a thickened nectary disk. Sepals and petals each 5; sepals persistent; petals white and deciduous, 12.5–13.5 mm long, obovate, rounded at apex, often held vertically and sidewise like propeller blades. Stamens 15+, attached to the nectary disk. Pistils 2–5, separate from each other, and stalked (stipitate), 7–11.5 mm long in fruit, cylindrical, and transversely wrinkled. Flowering mid-winter and spring; fruits mostly ripe in April. Seeds 4–8, with a conspicuous white- or yellow-fringed aril.

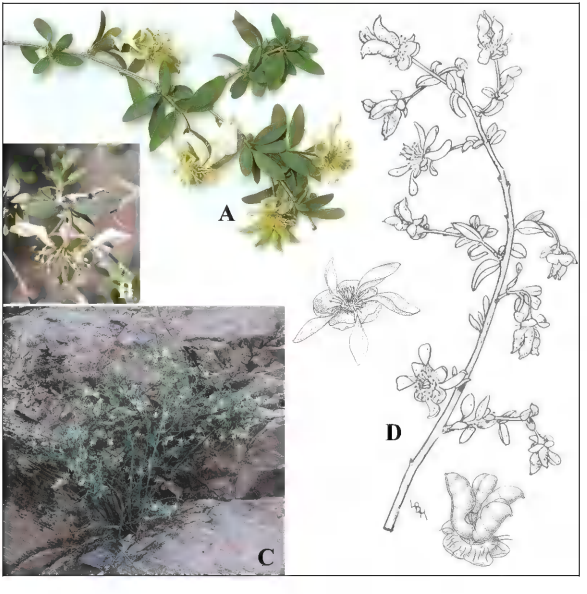

Figure 19. *Crossosoma bigelovii*. Estes Canyon: (A) 16 Mar 2008; (B) 2 Mar 2008. (C) South fork of Alamo Canyon, 28 Feb 2009. (D) By Lucretia Breazeale Hamilton.

Granitic and volcanic mountains, often rooted in bedrock canyon walls or cliff faces. Organ Pipe in the major ranges except the Quitobaquito Hills. Cabeza Prieta in the larger mountains, and in the Tinajas Altas Mountains. Its history across the flora area extends to more than 37,000 years.

Western and southern Arizona, northern Sonora (southward to the Guaymas Region), northwestern Chihuahua, western Nevada, inland southern California, and Baja California.

OP: Pitahaya Canyon, *Nichol 23 Feb 1939*. Alamo Canyon, *Tinkham 18 Apr 1942*. Above Dripping Springs, 16 Apr 1952, *Parker 7961*. Growler Mts, W of Growler Pass, 7 Mar 2003, *Rutman 2003-253* (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation). †Alamo Canyon, leaves, 8590 to 14,500 ybp (3 samples).

CP: Eagle Tank, 13 Jun 1992, *Felger* (observation). Canyon at Agua Dulce Tank, 26 Feb 1993, *Felger 93-86*.

TA: Tinajas Altas, 17 Mar 1980, *Webster 24254*. Borrego Canyon, vicinity Borrego Tank, 27 Feb 1993, *Felger 93-194*. †Tinajas Altas, leaves, fruits, 4010 to 15,680 ybp (9 samples), & >37,000 ybp.

CUCURBITACEAE – Gourd Family

Annuals and perennials (elsewhere sometimes shrubs and one succulent tree on Socotra Island in the Indian Ocean). Stems vining or trailing, the nodes with leaves and tendrils. The aerial parts of members of this family are frost-sensitive, although two of the six species in the flora area grow with cool-season rains; perennials in the flora area all have seasonal growth, the aerial parts dying back in unfavorable seasons. Leaves alternate, petioled, usually palmately veined and lobed; stipules none. Flowers unisexual, radial, the calyx and corolla each 5 lobed; corollas yellow or white. Stamens 3 or 5. Ovary inferior. Fruits highly variable; seeds 1 to many.

Worldwide, mostly tropical and subtropical; 120 genera, 835 species (Nesom in press). This family includes cucumbers, gourds, melons, pumpklins, squashes, and zucchinis.

1. Fruit a hard-shelled gourd 8 cm or more in diameter; flowers more than 2 cm wide..... **Cucurbita**
1. Fruit not a gourd, not hard-shelled, 3 cm or less in diameter; flowers less than 1.5 cm wide.

2. Plants growing with (or beginning just before) hot-weather rains.

3. Ephemerals; stems with 3-branched tendrils; leaves finely haired; fruits 2–2.5 cm long and spiny..... **Echinopepon**
3. Perennials; stems with simple (unbranched) tendrils; leaves glabrate or glabrous and smooth; fruits 1 cm long and smooth..... **Tumamoca**

2. Plants growing with cool-weather rains (fall to spring, or sometimes beginning in August).

4. Flowers less than 5 mm wide; fruits oblique (asymmetric), 1 cm long; lowlands…**Brandegea**
4. Flowers 6–10 mm wide; fruits globose, 2–3 cm in diameter; Ajo Mts..... **Marah**

Brandegea

This genus has a single species. It appears to be closely related to *Vaseyanthus insularis*, which replaces *Brandegea* southward in the Gulf of California region of the Sonoran Desert. Both grow with cool-season rains, although *Brandegea* sometimes grows following hot-weather rains.

Brandegea bigelovii (S. Watson) Cogniaux
Desert star-vine. Figure 20.

Ephemerals, mostly growing with cool season rains. Herbaceous vines from a stout, carrot-shaped, fleshy, white taproot often reaching 2–2.5+ cm in diameter. Stems slender, with simple

(unbranched) tendrils. Leaves highly variable, the blades 2.5–8 (12) cm long and about as wide, thin, prominently short-scabrous, shallowly to deeply 3 or 5 lobed, the lobes broader and shallower on juvenile growth, becoming narrower (to broadly linear) and deeper lobed on upper stems; petioles reaching 2–4 cm long. Flowers white and delicately fragrant; male and female flowers often in the same axil; male flowers 3–4 mm across, with 3 (5) stamens, in several-flowered racemes; female flowers larger, solitary on slender pedicels, 1 (2 or 3) per axil. Fruits 1- (2-) seeded, irregularly dehiscent, the body (6) 7–7.5 mm long, obovoid-oblique, laterally compressed, with soft prickles (warty), and a prominent beak (4) 5–7 mm long. Seeds 5 mm long.

Figure 20. *Brandegea bigelovii*. (A) Hwy 85, 12 miles S of Gila Bend, 31 Mar 2013. (B) Two staminate flowers and immature fruit, Tinajas Altas, 2 Mar 2014, photo by Sue Carnahan (SEINet–MABA). (C) Fruit, Daniels Arroyo at Charlie Bell Road, 5 Sep 2014. (D) Near Red Cone Campground, Pinacate Biosphere Reserve, Sonora, 18 Jan 2009. (E) Road to Red Cone Campground, Pinacate Biosphere Reserve, 7 Mar 2009.

Sandy-gravelly and loamy soils of washes and floodplains, often seasonally festooning trees and shrub in green curtains. Western part of Organ Pipe, widespread in Cabeza Prieta, and in the Tinajas Altas Region; common in adjacent Sonora. These plants are annuals (robust ephemerals) and growing mostly September–April but vigorous young growth sometimes seen in August following sufficient rains. The plants sometimes continue growing well into May, but such late season plants have relatively small leaves with narrow leaf lobes. The plants perish as the weather becomes hotter and drier in late spring and early summer. Is this plant capable of growing any time in summer of year with sufficient water? Is it facultatively perennial? In the California part of the Sonoran Desert it can germinate and grow with summer rains (Andrew Sanders, pers. comm. to Felger, Sep 2014).

Mojave and Sonoran Deserts; southeastern California to Baja California Sur, southwestern Arizona, and northwestern Sonora.

Seris used the roots to make a cleansing shampoo and a bitter infusion was drunk during vision quests to induce an altered state of consciousness (Felger & Moser 1985).

OP: 10 mi S of Bates Well, Growler Mts, 5 Mar 1940, *Benson 9932*. Near Quitobaquito, 5 Mar 1940, *Peebles 14556-a*. Senita Basin Rd, 12 Oct 1988, *Perrill 5875*. North Puerto Blanco Drive, 4.2 mi W of Hwy 85, 3 Dec 1990, *Felger 90-570*.

CP: Papago Well: Arroyo margin with mesquite and *Cercidium*, long climbing vine, 27 Oct 1937, *Gentry 5499* (ASU); *Nichol 13 Nov 1937*. Silt soil in lush overflow area of San Cristobal Wash, Monreal Well, *Simmons 21 Oct 1962*. Huge fragrant clumps, climbing over shrubby vegetation, esp. along dry wash, 1 mile E of Papago Well by the Camino del Diablo, 13 Mar 1983, *Eiber 15*. Lechuguilla Desert, SSW of Cabeza Prieta Peak, 13 Dec 1970, *Carr 106*. Buckhorn Tank, 28 Mar 1970, *Duncan 16*. Cabeza Prieta Mts, 1100 ft, 9 Mar 1986, *Schmidt 9-86*. Jose Juan Tank, 14 Sep 1992, *Felger 92-721*. N side of Tule Mts, 2 Feb 1992, *Felger 92-56*.

TA: Tinajas Altas, 5 Dec 1935, *Goodding 2092*. Tinajas Altas Pass, 17 Mar 1980, *Webster 24256*. Coyote Water, 21 Feb 2005, *Felger 05-139*.

California: Imperial County, Arroyo Seco, 4 km of Rainey's Well (Chuckwalla Spring), annual vine in wash, under *Parkinsonia florida*, flowers white, 22 Aug 2012, *Sanders 40373* (UCR).

Cucurbita

Perennial vines from a large, tuberous root (those in the flora area; annuals and perennials elsewhere). Male and female flowers on the same plant. Flowers large, yellow, and solitary. Stamens 3. Fruits of smooth, rounded gourds (those in the flora area). Seeds many, ovate, compressed, and smooth.

The large green-striped cushaw squash, *C. argyrosperma* Huber subsp. *argyrosperma* (*C. mixta* Pangalo), has been cultivated in the Sonoran Desert since ancient times. It has been grown along the lower Rio Colorado, at Quitovac, and undoubtedly at Quitobaquito and elsewhere in the region. It is distinguished by an enormous corky peduncle and large fruits (squashes). This genus includes wild and domesticated gourds and squashes.

Warm regions of the Americas; 14+ species.

1. Leaves (except newest growth, see below) divided nearly to the base with linear, finger-like segments or lobes…… **Cucurbita digitata**
1. Leaves with broad, mostly triangular lobes cleft to about the middle of the leaf.
…….. **Cucurbita palmata**

Cucurbita digitata A. Gray
Finger-leaf gourd, coyote gourd; *calabacilla, chichi coyota*; 'adavĭ, 'ad. Figure 21.

Perennials from a deep, thickened root. Stems relatively coarse, sprawling across the ground to several meters long, occasionally climbing into shrubs and trees. Herbage scabrous. Tendrils 2–5-branched. Leaf blades digitately and deeply cleft, the lobes (6) 8–13 cm long, slender and finger-like, the upper surfaces whitish near the midrib due to dense concentration of hairs and greenish near the margins, the petioles 4–9 cm long; leaves of juvenile plants and first growth of season with much shorter and broader lobes (like those of *C. palmata*). Corollas bright yellow, 7–10 cm across. Gourds 8–9.5 cm in diameter, rounded, smooth, green with whitish stripes and mottling, yellow at maturity with a thin but hard rind. Seeds 9–11 mm long, smooth, compressed, and whitish. Growing and flowering with warm weather, often beginning in spring even in dry years, dying back in severe drought.

Washes, canyons, and sandy to loamy flats, also roadsides; widely scattered across Organ Pipe including Ajo Mountain canyons and in Cabeza Prieta and Tinajas Altas regions.

Southern Arizona, northern Sonora, northern Baja California, northwestern Chihuahua, southern New Mexico, and rare in southern California.

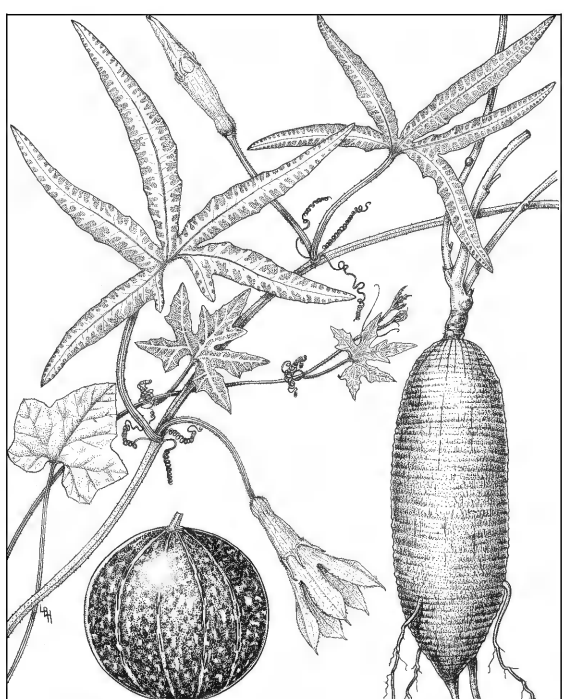

Figure 21. *Cucurbita digitata*. By Lucretia Breazeale Hamilton.

The roots were used as a medicine to treat dandruff and were also mashed in water for use as soap and bleach for fabric (Betty Melvion in Bell et al. 1980). "Wild gourds. . . my grandmother used to slice them up and put them. . . in the water where she was soaking her sheets, the white sheets. . . for bleach in the wash. The wash would come out so white. … with the roots of the gourds they use it to wash their hair. . . its almost like adding Clorox to the wash. . . they would use the gourd in this way when it was still green, not when it was dry" (Betty Melvin in Zepeda 1985: 49, 54).

The fruits are very bitter and not edible, although the seeds are reported to be edible after being toasted or boiled and ground into flour (Hodgson 2001). River Pimas used juice from the root, extracted by pounding in a mortar and boiling, as ear drops to alleviate earache (Russell 1908).

OP: Cipriano Well, *Nichol 27 Apr 1939*. 1 mi W of Growler Pass, 1000 ft, *Simmons 1 Oct 1963*. Armenta Well, *Warren 16 Nov 1974*. Alamo Canyon, near corral, *Van Devender 31 Aug 1978* (ORPI). Quitobaquito, 24 Oct 1990, *Felger 90-493* (ORPI).

CP: Bluebird Mine (Simmons 1966). Daniels Wash at Charlie Bell Rd, 18 Aug 1992, *Felger 92-671*.

TA: Tinajas Altas, *Goodding 5 Dec 1935*. Tinajas Altas Pass, 1100 ft, washes, *Reeves R5408* (ASU). Frontera Canyon, 18 Mar 1998, *Felger* (observation).

Cucurbita palmata S. Watson

Coyote gourd; *calabacilla, chichi coyota*; 'adavï, 'ad. Figure 22.

Similar to *C. digitata* but with much broader and shorter leaf segments or lobes, the leaf lobes more or less triangular, often nearly as broad as long, and usually with entire margins.

Figure 22. *Cucurbita palmata*. (A) About 6 mi S of Ludlow, San Bernardino Co., California, 25 Sep 2011. (B) Vicinity of Hwy 58 & 223, Kern Co., California, 19 Sep 2009. Photos © by Neal Kramer.

Sandy soils of Lechuguilla Valley and arroyo bottoms of the Tinajas Altas Mountains. Often growing over shrubs.

Southwestern Arizona, northwestern Sonora near the Río Colorado, southeastern California, northeastern Baja California, Nevada, and southwestern Utah.

Cucurbita palmata generally replaces *C. digitata* in the western margin of the flora area, where *C. palmata* locally occurs in more xeric, harsher habitats than does *C. digitata*. The leaves of

juvenile plants or the first growth of the season of *C. digitata* are essentially indistinguishable from those of both the juvenile and adult leaves of *C. palmata*. These taxa are part of a complex of several closely related, arid-region cucurbits in southwestern USA and northwestern Mexico that might be considered as subspecies of a single species (Bemis & Whitaker 1965).

TA: Camino del Diablo, E of Raven Butte, valley floor bajada, decomposed gravel sand soil, 29 Nov 2001, *Felger 01-584* (ARIZ, ASU).

Echinopepon

Herbaceous vines. Southwestern USA to Central America and disjunct in Argentina; 19 species.

Echinopepon wrightii (A. Gray) S. Watson
Wild balsam-apple. Figure 23.

Figure 23. *Echinopepon wrightii*. (A & C) Arch Canyon, 16 Sep 2006. (B & D) Estes Canyon, 22 Sep 2013.

Robust summer-fall ephemeral (annual) vines, growing into or over shrubs and trees. Plants with glandular and non-glandular hairs. Tendrils mostly 3-branched. Leaf blades to 12 cm long, thin, cordate and generally palmately 3–5-lobed. Flowers white. Mature fruits become capsules, the body 2–3.5 cm long and covered with spines 1–2.5 cm long, the fruit body and spines bear stalked glands. Capsules 3-chambered, the seeds shed from apical pores; capsules often hanging in trees on the dry, dead vines for several months.

Canyons and upper slopes in the Ajo Mountains.

Mostly along the upper elevational edge of the Sonoran Desert and adjacent non-desert zones. Southern Arizona, southern New Mexico, and northern Mexico including Baja California Sur, Chihuahua, and Sonora.

OP: Alamo Canyon, 14 Dec 1939, *Harbison 26431* (SD). Arch Canyon, 3000 ft, *Wirt 13 Oct 1990*. Below arch in Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-563*. Estes Canyon, 0.1–0.2 mi upstream from Estes Canyon Picnic area, 738 m, uncommon vine, sprawling among rocks in wash bed, 22 Sep 2013, *Rutman 20130922-30*.

Baja California Sur: Sierra Guadalupe, W of Mulegé, S of Rancho San Sebastian near Ranchos San Fernando, 26°59'20"N, 112°27'33"W, 2952 ft, 27 Oct 1997, *Rebman 4586* (SD, UCR).

Marah – Manroot

Perennial vines from large tuberous roots. Western North America; 8 species.

Marah gilensis (Greene) Greene

Big root, Gila manroot. Figure 24.

Robust perennial vines from a very large tuberous root, the vines climbing on trees and shrubs; growing and flowering during the cooler months and summer dormant. New growth and inflorescences densely pubescent, with age becoming glabrate. Tendrils simple or 2-branched. Leaf blades thin, palmately (3) 5 (7)-lobed, scabrous above, glabrous or sparsely pubescent below, especially along major veins. Flowers pale yellow or greenish yellow, 6–10 mm wide; male and female flowers in the same axil. Fruits sub-globose, 2–3 cm wide, with many herbaceous prickles, succulent when green, becoming dry at maturity; seeds 3 or 2 when 1 does not develop. Flowering December–March.

Ajo Mountains, locally common in canyon bottoms and slopes, mostly at higher elevations.

Eastward and northward in Arizona, few records in southwestern New Mexico, and expected in northern Sonora.

OP: Alamo Canyon: 2500 ft, *Nichol 14 Mar 1939*; 14 Dec 1939, *Harbison 26258*; steep N- facing slopes, 9 Mar 1946, *Goodding 12-46*. S side of Arch Canyon, 3500 ft, 28 Mar 1965, clambering over shrubs of *Lycium parishii* and *Encelia farinosa*, *Niles 555*. Side canyon of Arch Canyon, just W of the Natural Arch, 3000 ft, vine climbing on *Simmondsia chinensis*, 25 Feb 1978, *Bowers 1061*. Arch Canyon trail, 2550–2900 ft, 11 Mar 1983, *Daniel 2620* (UCR).

Figure 24. *Marah gilensis*. South fork of Alamo Canyon: (A) 26 Feb 2014; (B) staminate flowers, 14 Jan 2014; (C) 12 Mar 2005. (D) 50-pound tuber, Boyce Thompson Arboretum, Gila Co., 29 Oct 2011, photographer unknown.

Tumamoca – Globe-berry

In collaboration with Frank Reichenbacher.

This genus is named for Tumamoc Hill, Tucson, site of the Carnegie Institute Desert Laboratory, founded in 1905, which later became part of the University of Arizona. Some of the most important scholars of desert ecology headquartered or began their careers at Tumamoc Hill including Julio Betancourt, Tony L. Burgess, Janice E. Bowers, Kenneth L. Cole, Francis Lloyd, Daniel T. MacDougal, Vera Markgraf, Paul S. Martin, Peter J. Mehringer, Kate Aason Rylander, Geoffrey W. Spaulding, Volney Spaulding, Forrest Shreve, Godfrey Sykes, Robert S. Thompson, Raymond M. Turner, Thomas R. Van Devender, and Robert H. Webb, as well as a number of distinguished archeologists.

Tumamoca is closely related to *Ibervillea* (Nesom in press) and indeed shows some overall resemblance to *I. sonorae* (S. Watson) Greene, *guarequi*, a well-known Sonoran Desert plant in northwestern Mexico. They are, however, clearly distinctive. A second species of *Tumamoca*, *T. mucronata* Kearns, is known only by the type specimen (Kearns 1994) and that specimen has not been located in recent years (Tom Wendt, pers. comm. to Felger, 11 Mar 2015).

Lira et al. (2015) have placed *Ibervillea* (including *Dieterlea*) and *Tumamoca* in the same genus, and the name *Ibervillea* has priority. A cladistic analysis, based on morphological as well as molecular data, indicates that *Tumamoca* is sister to the core *Ibervillea*, thus *Ibervillea* is monophyletic even if *Tumamoca* is not included and the rationale for expanding *Ibervillea* is equivocal. Another genus, the Southern Hemisphere *Ceratosanthes*, is sister to the *Ibervillea*/*Tumamoca* clade. The strength of the case for combining all three American genera is that they are indeed similar and form an obviously coherent geographical group in "Megamexico" (sensu Rzedowski 1991). While the inclusion of *Tumamoca* is justifiable, so also is a decision to keep it separate — we believe that Lira et al. have provided weak support for their decision and prefer to emphasize the distinction of *Tumamoca*.

Tumamoca macdougalii Rose
[*Ibervillea macdougalii* (Rose) Lira, Dávila & Legaspi]
Tumamoc globe-berry. Figure 25.

Perennials from tuberous roots that vary in shape, size, number, and configuration. Tuberous roots of juvenile plants tend to be carrot-shaped and 10–40 cm long, and those of adult plants are carrot- or potato-shaped, single, or clustered, horizontal or vertical, in soil deep or shallow; the largest ones may weigh 2 kg and are from 40–80 cm long. Plants glabrous or glabrate, the young herbage sometimes very sparsely pubescent. Stems slender and vining, climbing in shrubs, trees, or cacti—potentially climbing as much as 3 m above ground. New growth appears with summer rains, or just prior to monsoon onset in the larger adult plants, in which case minute flower buds may appear and are successively aborted until the rain arrives; the stems and leaves quickly perish when the rains cease. Tendrils simple (unbranched). Leaf blades deeply parted or divided, often about 4 x 4 cm. Male and female flowers variously on the same or different plants (sub-monoecious); apparently self-compatible and moth-pollinated (Reichenbacher 1990). Male flowers on short racemes, the female flowers solitary; flowers pale yellow, the lobes spreading and sometimes recurved. Fruits globose, 1 cm in diameter, glabrous and fleshy, at first green with white mottling, becoming uniformly bright red when ripe in late summer–early fall; seeds several or more per fruit.

Known from several scattered localities in Organ Pipe, where it is at its westernmost limit. The plants are often hidden in shrubs and not easy to find, and generally can be located only during the brief summer rainy season.

Southern Arizona from Organ Pipe to the Tucson Region, western Sonora to northwestern Sinaloa, and Isla Tiburón.

"Tumamoc globeberry is always found in the shade of and among the canopies of…shrubs and trees. These … 'nurse plants' provide habitat for seed germination, shelter for seedlings and juveniles, and support for the display of flowers to potential pollinators and presentation of fruits to potential seed dispersers" (Reichenbacher 2008: 6). Frank Reichenbacher and associates have been monitoring this species in southern Arizona since 1983 and have noted a substantial decrease in the number of plants in certain Tucson populations (Reichenbacher 2008; Frank Reichenbacher, pers. comm. to Felger, 2015). The Tumamoc globe-berry was listed as an endangered species in 1986 but was removed from the endangered species list in 1993 (U.S. Fish & Wildlife Service 1986, 1993).

The small red fruits have been eaten fresh by the Seris (Felger & Moser 1985; Felger & Wilder 2012).

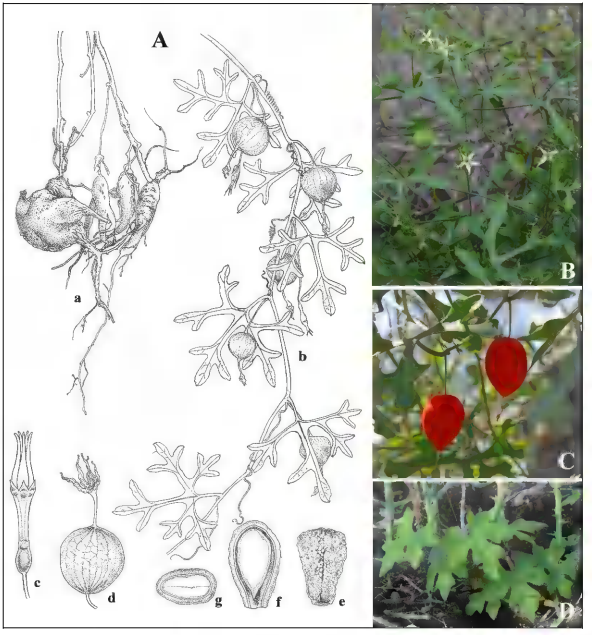

Figure 25. *Tumamoca macdougalii*. (A) Copy of illustration accompanying the original description by Rose (1912: plate 17): "a, Cluster of roots; b, fruiting branch; c, flower; d, fruit with old flower; e, seed; f, longitudinal section of seed; g, cross section of seed." See text for comments on this illustration. (B) Sabino Canyon, Santa Catalina Mts, Pima Co., 21 Aug 2011. (C) Anklam Road near Tumamoc Hill, Tucson, 25 Aug 2012. (D) Tumamoc Hill, 25 Aug 2012. Photos by Frank Reichenbacher.

Frank Reichenbacher provided the following comments for Figure 25A, which is a copy of the illustration accompanying the original description of *Tumamoca* by Rose (1912):

"This is an excellent illustration but suffers a lack of comparative data available to Rose and the anonymous illustrator. The 'cluster of roots' appears to be two separate plants. In the 200+ plants excavated from the Central Arizona Project route (Reichenbacher 1990) none appeared to have roots as fragmented as the one shown in 'a.' All of the flowers in this illustration are female. The characteristic male racemes are not shown. The flower bud in the top of the illustration, just above 'b,' appears to be shown with subtending bracts, which *T. macdougalii* does not have. The fruit illustrated in 'd'. was green (not ripe)—when the fruits are ripe, the mottling disappears in favor of a monochromatic red. The illustrator was not given an open flower to draw, so the flower shown in 'c' (also a female flower) gives the impression that this is what they look like. In fact the corolla flares widely and the lobes even recurve."

OP: Dripping Springs, 27 Oct 1951, *Supernaugh 453* (ORPI). E of Dos Lomitas, *Prosopis-Cercidium* wash through *Atriplex* flats, vine growing through *Atriplex polycarpa* along outside of wash, 11 Oct 1988, *Baker 7638* (ASU, ORPI). N of Lukeville, under a mesquite, about one dozen small to large plants, *Rutman 16 Aug 1997* (ORPI). Hwy 85, milepost 71, creosote bush flat, growing up into a creosotebush, 1 mi N of Cherioni Wash, 12 Sep 2004, *Rutman*, photo.

ACKNOWLEDGEMENTS

In addition to the gratitudes provided in part 1 in this flora series, we thank Susan Davis Carnahan for copyediting expertise. George Ferguson, Richard (Rick) Alan Johnson, Guy L. Nesom, Andrew M. Salywon, Andrew C. Sanders, Frank Reichenbacher, Thomas R. Van Devender, James (Jim) Thomas Verrier, and George Yatskievych provided significant information and reviews.

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NEW NAMES AND NEW COMBINATIONS FOR THE CATALOGUE OF THE PLANTS AND LICHENS OF COLOMBIA

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ABSTRACT

Sixty-seven new combinations, replacement names and changes of status are validated for Colombian plants and lichens in the families Parmeliaceae (Lichenes), Lophocoleaceae (Marchantiophyta), and Apocynaceae, Arecaceae, Asteraceae, Bromeliaceae, Brunelliaceae, Clusiaceae, Ericaceae, Fabaceae, Hypericaceae, Lamiaceae, Melastomataceae, Orchidaceae, Orobanchaceae, Oxalidaceae, Passifloraceae, Piperaceae, Rubiaceae, and Rutaceae (Angiosperms).

In the forthcoming Catalogue of the Plants and Lichens of Colombia (Catálogo de Plantas y Líquenes de Colombia) (Bernal et al., in press), 67 name changes are being proposed, including 59 new combinations, 10 replacement names, and 13 changes of status. Validations of name changes were originally planned to be included in an appendix to the printed version of the Catalogue, which was to be released simultaneously with the online version. However, as the printing process will take longer than anticipated, it was decided to publish the online version first, which prompts validating the new names separately. The new names are proposed here.

Note that the new combinations, replacement names, and changes of status proposed here should be attributed exclusively to the authors mentioned for each of them, not to the editors of the Catalogue.

LICHENES

PARMELIACEAE

Imshaugia angustior (Nyl.) Sipman, **comb. nov**. Basionym: *Parmelia angustior* Nyl., Ann. Sci. Nat., Bot., sér. 4, 11: 215 (1859).

MARCHANTIOPHYTA

LOPHOCOLEACEAE

Cryptolophocolea martiana var. **perissodonta** (Spruce) Gradst., **comb. nov.** Basionym: *Lophocolea martiana* var. *perissodonta* Spruce, Trans. & Proc. Bot. Soc. Edinburgh 15: 432, 1885.

ANGIOSPERMS

APOCYNACEAE

Ibatia cumanensis (Willd. ex Schult.) Morillo, **comb. nov.** Basionym: *Apocynum cumanense* Willd. ex Schult., Syst. Veg. ed. 15 bis 6: 796. 1820.

Ibatia dugandii (Krings) Morillo, **comb. nov.** Basionym: *Matelea dugandii* Krings, Syst. Bot. 34(2): 430–433, figs. 1–3. 2009.

Ibatia fontana (Saville & Krings) Morillo, **comb. nov.** Basionym: *Matelea fontana* Saville & Krings, Syst. Bot. 32(4): 864–865; fig. 2. 2007.

Ibatia holstonii (Vail) Morillo, **comb. nov.** Basionym: *Stelmagonum holtonii* Vail, Bull. Torr. Bot. Club 26(8):424–25. 1899.

Ibatia rubra (H. Karst.) Morillo, **comb. nov.** Basionym: *Omphalophthalma rubra* H.Karst., Fl. Columb. (H. Karst.) 2: 119, t. 163. 1866.

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ARECACEAE

Geonoma interrupta subsp. **platybothros** (Burret) Galeano & R. Bernal, **comb. et stat. nov.** Basionym: *Geonoma platybothros* Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11: 200. 1931.

Geonoma interrupta subsp. **ramosissima** (Burret) Galeano & R. Bernal, **comb. et stat. nov.** Basionym: *Geonoma ramosissima* Burret, Bot. Jahrb. Syst. 63: 249. 1930.

ASTERACEAE

Jungia gunnerifolia (S. Díaz) M. Diazgranados & F. Ávila, **comb. nov.** Basionym: *Tostimontia gunnerifolia* S. Díaz, Revista Acad. Colomb. Ci. Exact. 25(94): 9–10, f. 1–2. 2001.

BROMELIACEAE

Vriesea myriantha (Baker) Betancur, **comb. nov.** Basionym: *Tillandsia myriantha* Baker, J. Bot. 25: 242. 1887.

BRUNELLIACEAE

Brunellia susaconensis (Cuatrec.) C.I. Orozco, **comb. et stat. nov.** Basionym: *Brunellia propinqua* subsp. *susaconensis* Cuatrec., Fl. Neotrop. Monogr. 2 (Suppl.): 72–73, f. 21. 1985.

CLUSIACEAE

Clusia caryophylloides (Planch. & Triana) Hammel, **comb. nov.** Basionym: *Havetiopsis caryophylloides* Planch. & Triana, Ann. Sci. Nat., Bot., sér. 4, 14: 248. 1860.

Clusia nigrolineata P.F. Stevens, **nom. nov.** Basionym: *Decaphalangium peruvianum* Melchior, Notizbl. Bot.Gart. Berlin-Dahlem 10(99): 947, f. 16. 1930. Non *Clusia peruviana* Szyszyl., Diss. Cl. Mat.-Phys.Acad. Litt. Cracov 29: 225. 1894.

Clusia quadrata (Cuatrec.) Hammel, **comb. nov.** Basionym: *Pilosperma quadratum* Cuatrec., Revista Acad. Colomb. Ci. Exact. 8(29): 60. 1950.

Garcinia magnophylla (Cuatrec.) Hammel, **comb. et stat. nov.** Basionym: *Rheedia chocoensis* Cuatrec. var. *magnophylla* Cuatrec. Anales Inst. Biol. Univ. Nac. México 20: 107, 1949.

Garcinia pulvinata (Planch. & Triana) Hammel, **comb. nov.** Basionym: *Rheedia pulvinata* Planch. & Triana, Ann. Sci. Nat., Bot. (ser. 4) 14: 320. 1860.

ERICACEAE

Thibaudia haughtii (A.C. Sm.) Luteyn, **comb. nov.** Basionym: *Cavendishia haughtii* A.C.Sm., Contr. U. S. Natl. Herb. 29: 390. 1959.

Thibaudia insignis (A.C. Sm.) Luteyn & Pedraza, **comb. nov.** Basionym: *Calopteryx insignis* A.C.Sm., J. Arnold Arbor. 27(1): 100–103, f. 2. 1946.

FABACEAE

Lupinus oscarii R. Bernal, **nom. nov.** Basionym: *Lupinus guadalupensis* C.P. Sm., Species Lupinorum 41:706–707. 1951. Non *Lupinus guadalupensis* Greene, Bull. Calif. Acad. Sci. 1(4A): 184. 1886 [1885].

Although the taxonomic status of this taxon is still uncertain, a new name is required for it. Named after Oscar Haught, who collected the type specimen.

Schnella guianensis var. **SPLENDENS** (Kunth) R. Bernal & Celis, **comb. nov.** Basionym: *Bauhinia splendens* Kunth, Nov. Gen. Sp. (quarto ed.) 6: 321. 1823. *Bauhinia guianensis* var. *splendens* (Kunth) Amshoff.

Schnella hymenaeifolia var. **stuebeliana** (Harms) R. Bernal & Celis, **comb. nov.** Basionym: *Bauhinia stuebeliana* Harms, Repert. Spec. Nov. Regni Veg. 19(4–7): 65. 1923. *Bauhinia hymenaeifolia* var. *stuebeliana* (Harms) Wunderlin.

HYPERICACEAE

Hypericum strictum subsp. **gracile** (Triana & Planch.) N. Robson, **comb. et stat. nov.** Basionym: *Hypericum struthiolifolium* var. *gracile* Triana & Planch., Ann. Sci. Nat., Bot. sér. 4, 18: 294. 1862

LAMIACEAE

Scutellaria ventenatii var. **trianae** (Planch. & Lindl.) Fern. Alonso, **comb. et stat. nov.** Basionym: *Scutellaria trianae* Planch. & Lindl., Cat. Général 10: 6. 1856.

MELASTOMATACEAE

Blakea droseropila Penneys, **nom. et stat. nov.** Basionym: *Blakea podagrica* ssp. *ciliata* Wurdack, Phytologia 6: 3.1957.

Blakea pectinata Penneys, **comb. et nom. nov.** Basionym: *Topobea andreana* Cogn., Bull. Acad. Roy. Sci. Belgique Ser. III, xiv. 974. 1887; et in DC. Monog. Phan. vii. 1085. 1891. Non *Blakea andreana* Cogn., Bull. Acad. Roy. Sci. Belgique, ser. 3, 14: 969. 1887.

Chalybea calyptrata (Penneys & Morales-P.) Penneys & Morales-P., **comb. nov.** Basionym: *Huilaea calyptrata* Penneys & Morales-P., Brittonia 62: 30. 2010.

Chalybea ecuadorensis (Wurdack) Morales-P. & Penneys, **comb. nov.** Basionym: *Huilaea ecuadorensis* Wurdack, Phytologia 69: 324. 1990.

Chalybea kirkbridei (Wurdack) Morales-P. & Penneys, **comb. nov.** Basionym: *Huilaea kirkbridei* Wurdack, Brittonia 28: 141. 1976.

Chalybea macrocarpa (Uribe) Morales-P. & Penneys, **comb. nov.** Basionym: *Huilaea macrocarpa* Uribe, Caldasia 9: 298. 1966.

Chalybea minor (Uribe) Morales-P. & Penneys, **comb. nov.** Basionym: *Huilaea macrocarpa* subsp. *minor* Uribe, Caldasia 12: 17. 1977; *Huilaea minor* (Uribe) Lozano-C. & Ruiz, Revista Acad. Colomb. Ci. Exact. 20: 240. 1996.

Chalybea mutisiana (Uribe) Morales-P. & Penneys, **comb. nov.** Basionym: *Huilaea mutisiana* Uribe, Caldasia 10: 295. 1969.

Chalybea occidentalis (Lozano-C. & N. Ruiz-R.) Morales-P. & Penneys, **comb. nov.** Basionym: *Huilaea occidentalis* Lozano-C. & Ruiz, Revista Acad. Colomb. Ci. Exact. 20: 238. 1996.

Chalybea penduliflora (Wurdack) Morales-P.& Penneys, **comb. nov.** Basionym: *Huilaea penduliflora* Wurdack, Brittonia 9: 106. 1957.

Miconia cornuta (Lozano & N. Ruiz-R.) Almeda & Alvear, **comb. nov.** Basionym: *Sagraea cornuta* Lozano & N.Ruiz-R., Mutisia 75: 3, fig.1. 1995.

Miconia discoidea (Lozano & N. Ruiz-R.) Almeda & Alvear, **comb. nov.** Basionym: *Sagraea discoidea* Lozano & N.Ruiz-R., Mutisia 75: 4, fig.2. 1995.

Miconia munchicana (Lozano & N.Ruiz-R.) Almeda & Alvear, **comb. nov.** Basionym: *Sagraea munchicana* Lozano & N.Ruiz-R., Mutisia 75: 4, fig.3. 1995.

Monochaetum expansum (Gleason) Alvear & Almeda, **comb. et stat. nov.** Basionym: *Monochaetum bonplandii* (Kunth) Naudin var. *expansum* Gleason, Amer. J. Bot. 16: 517. 1929.

Triolena agrimonioides (Triana) Almeda & Alvear, **comb. nov.** Basionym: *Diolena agrimonioides* Triana, Trans. Linn. Soc. London 28(1): 81. 1871.

Triolena auriculata (Triana) Almeda & Alvear, **comb. nov.** Basionym: *Diolena auriculata* Triana, Trans. Linn. Soc. London 28(1): 81. 1871.

Triolena lanceolata (Gleason) Almeda & Alvear, **comb. nov.** Basionym: *Diolena lanceolata* Gleason, Bull. Torrey Bot. Club 52: 374–375, f. 2. 1925.

Triolena paleacea (Triana) Almeda & Alvear, **comb. nov.** Basionym: *Diplarpea paleacea* Triana, Trans. Linn. Soc. London 28: 80. 1871.

Triolena purpurea (Gleason) Almeda & Alvear, **comb. nov.** Basionym: *Diolena purpurea* Gleason, Bull. Torrey Bot. Club 68: 246. 1941.

ORCHIDACEAE

Stelis roseopunctata (Lindl.) R. Bernal, **comb. nov.** Basionym: *Pleurothallis roseopunctata* Lindl., Orchid. Linden.: 2 (1846).

OROBANCHACEAE

Buchnera schultesii R. Bernal, **nom. nov**. Basionym: *Buchnera rubriflora* Philcox, J. Arnold Arbor. 59(3):298, 1978. Non *Buchnera rubriflora* P.A. Duvign. & Van Bockstal in G. Viennot-Bourgin, Rapp. Sol & Vég. 131, 1960.
Named after Richard Evans Schultes, who collected the type specimen.

OXALIDACEAE

Oxalis neorufescens R. Bernal, **nom. nov.** Basionym: *Oxalis rufescens* Turcz., Bull. Soc. Imp. Naturalistes Moscou 31(1): 429. 1858. Non *Oxalis rufescens* Willd. ex Zucc., Denkschr. Königl. Akad. Wiss. München 9: 162. 1825.

PASSIFLORACEAE

Passiflora lawessonii P. Jorg., **nom. nov.** Basionym: *Passiflora montana* Holm-Niels. & Lawesson, Ann. Missouri Bot. Gard. 74: 499, f. 2. 1987. Non *Passiflora montana* (Barb. Rodr.) Harms, Nat. Pflanzenfam. 3(6a): 256. 1897.

PIPERACEAE

Piper caballetense R. Bernal, **comb. et nom. nov.** Basionym: *Trianaeopiper santarosanum* Trel., Proc. Amer. Philos. Soc. 67: 336, t. 1928. Non *Piper santarosanum* C. DC., Bot. Gaz. 19(7): 258. 1894.
Named after the Caballete river, where the type specimen was collected.

Piper contraverrugosa (Cuatrec.) R. Bernal, **comb. nov.** Basionym: *Trianaeopiper contraverrugosa* Cuatrec., Revista Acad. Colomb. Ci. Exact. 7: 51, t. 1. 1946.
The specific epithet is the plant's common name used in apposition; because of this, it does not change gender.

Piper corei (Yunck.) R. Bernal, **comb. nov.** Basionym: *Ottonia corei* Yunck., Amer. J. Bot. 43: 166. 1956.

Piper cuatrecasasii (Trel. & Yunck.) R. Bernal, **comb. nov.** Basionym: *Trianaeopiper cuatrecasasii* Trel. & Yunck., Piperac. N. South Amer. 1: 424–425, f. 383. 1950.

Piper ellsworthii (Trel. & Yunck.) R. Bernal, **comb. nov.** Basionym: *Trianaeopiper ellsworthii* Trel. &Yunck., Piperac. N. South Amer. 1: 433–434, f. 393. 1950.

Piper inopinum R. Bernal, **comb. et nom. nov.** Basionym: *Artanthe auriculata* Miq., Linnaea 20: 167. 1847. *Piper auriculatum* (Miq.) C. DC., Prodr. 16(1): 372. 1869. Non *Piper auriculatum* Blume, Verh. Batav. Genootsch. Kunst. 11: 171. t. 8, 1826.

Piper josephii R. Bernal, **nom. nov.** Basionym: *Trianaeopiper silvaticum* Cuatrec., Revista Acad. Colomb. Ci. Exact. 7: 51. 1946. Non *Piper sylvaticum* Roxb., Fl. Ind. (Carey & Wallich ed.) 1: 158 (–159). 1820.

Named after José Cuatrecasas, who collected the type and described the species. The epithet is based in the old Spanish form of the name, Joseph.

RUBIACEAE

Psychotria pseudaxillaris (Wernham) Delprete, **comb. nov.** Basionym: *Cephaelis pseudaxillaris* Wernham, J. Bot. 55: 284. 1917.

RUTACEAE

Zanthoxylum schreberi (J.F. Gmel.) Reynel, **comb. nov.** Basionym: *Curtisia schreberi* J.F. Gmel., Syst. Nat. 2(1): 498. 1791.

Zanthoxylum fagara subsp. **culantrillo** (Kunth) Reynel, **comb. et stat. nov.** Basionym: *Zanthoxylum culantrillo* Kunth, Nov. Gen. Sp. (quarto ed.) 6: 2–3. 1823.

Zanthoxylum martinicense subsp. **amoyense** (Tul.) Reynel, **comb. et stat. nov.** Basionym: *Zanthoxylum amoyense* Tul., Ann. Sci. Nat., Bot., sér. 3, 7: 277. 1847.

Zanthoxylum riedelianum subsp. **hygrophilum** (Cuatrec.) Reynel, **comb. et stat. nov.** Basionym: *Fagara hygrophila* Cuatrec., Revista Acad. Colomb. Ci. Exact. 8: 301. 1951.

Zanthoxylum riedelianum subsp. **kellermanii** (P. Wilson) Reynel, **comb. et stat. nov.** Basionym: *Zanthoxylum kellermanii* P. Wilson, N. Amer. Fl. 25(3): 195. 1911.

Zanthoxylum acuminatum subsp. **juniperinum** (Poepp.) Reynel, **comb. et stat. nov.** Basionym: *Zanthoxylum juniperinum* Poepp., Nov. Gen. Sp. Pl. 3: 77. 1845.

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ELEOCHARIS ×INAEQUILATERA (CYPERACEAE), A NEW HYBRID SPIKERUSH FROM THE COASTAL PLAIN OF LOUISIANA AND TEXAS

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ABSTRACT

Eleocharis ×inaequilatera D.J. Rosen & C. Reid, **nothosp. nov.**, a new sterile hybrid spikerush, is described from the coastal plain of Louisiana and Texas. The hybrid is hypothesized to result from crossing of *E. cellulosa* Torr. and *E. quadrangulata* (Michx.) Roem. & Schult., based on intermediacy of characteristics of the culm in the hybrid and frequent sympatry of these two species in wetlands throughout the hybrid's known range.

Over a decade of field work in the Gulf Coastal plain aimed in most cases at collecting members of *Eleocharis* subg. *Limnochloa* led to collections of a sterile, asexually reproducing *Limnochloa* at five different sites throughout the coastal plain of Louisiana and Texas. This entity was encountered in wetlands where both *E. cellulosa* Torr. and *E. quadrangulata* (Michx.) Roem. & Schult. (or at least one of these species) were also present. We describe this plant as a single nothotaxon apparently resulting from independent crossing events between the same putative parents.

Eleocharis ×inaequilatera D.J. Rosen & C. Reid, **nothosp. nov**. **TYPE: USA. Louisiana.** Beaureguard Parish: Seasonally flooded pond surrounded by pine forest N of Arco Road, 1.7 km from its intersection with Parish Rd 33, locally dominant with *Eleocharis cellulosa* and *E. quadrangulata*, 27 Aug 2010, *D.J. Rosen, C. Reid, & L. Urbatsch 5048* (holotype: TEX; isotypes: BRIT, LSU, NO, US, VSC). Figure 1.

Culm cross-section immediately below the spikelet intermediate between the obscurely 3-angled to subtrigonous *E. cellulosa* and the acutely and unequally quadrangular *E. quadrangulata*.

Plants perennial. **Roots** coarse, fibrous, dark gray-brown; rhizomes long, 1.8–3 mm thick. **Culms** to 85 cm × 2–3.2 mm, soft when fresh, internally spongy-aerenchymatous with incomplete transverse septa, unequally quadrangular, the angles never sharp, the faces more or less flat but never deeply concave, the widest about 2× times that of the narrowest giving the culms a nearly trigonous outline. **Sheaths** membranous, loose, friable, orangish to tan basally, maroon distally, apically oblique, the apex usually extended into a soft awn. **Spikelets** cylindric, 2.9–6.5 cm × 3–3.6 mm, first scale amplexicaul and appearing as continuation of culm; floral scales appressed (in both fresh plants and after drying), ovate to broadly ovate, apex broadly rounded, distal 0.3–0.5 mm hyaline-erose, central area broadly keeled from base to near middle, 4.5–6.2 × 3.2–3.6 mm, with many fine longitudinal cellular-lineate veins, midvein evident only in adaxial view, centrally indurate, stramineous, adaxially sparsely to densely red-maculate, abaxially sparsely red-maculate with a dark reddish brown band near apex. **Flowers** with 7–8 perianth bristles; bristles straight to tortuous, fine,

smooth or infrequently minutely nodulose (seen only at high [40X] magnification) at the tips; stamens 3; anthers 1.6–2.9 mm long, yellow; style 3-fid. **Achenes** aborted.

The name of this hybrid spikerush describes the unequal nature of the four-sided culms.

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UNIVERSITY OF TEXAS HERBARIUM
HOLOTYPE OF:
Eleocharis ×inaequilatera
D.J. Rosen & C. Reid
CYPERACEAE
U.S.A., LOUISIANA
Beauregard Parish
HOLOTYPE
Eleocharis × inaequilatera D.J. Rosen & C. Reid
Take Neale Oilfield Road (Parish Rd. 33) 4.6 km E of its intersection with Hwy. 110 in the town of Merryville. Turn left on Arco Rd. and travel 1.7 km. Seasonally flooded pond surrounded by pine forest N of Arco Rd. Locally dominant perennial with Eleocharis cellulosa, E. quadrangulata, Hydrolea ovata, Rhynchospora corniculata, Ludwigia linearis, Juncus elliottii, and Xyris sp.
GPS – N30.77259 W93.48170 (WGS 84)
D.J. Rosen 5048
C. Reid, L. Urbatsch
27 August, 2010
00208802

Figure 1. Holotype of *Eleocharis ×inaequilatera*.

Additional specimens examined. Louisiana. Beauregard Par.: Type locality, 8 Oct 2008, *Reid and Allain 6844* (topotype: LSU). St. Tammany Par.: at the corner of Bertha Lane and Mildred Road, common colonial herbs in marsh along roadside with *Juncus roemerianus* and *Spartina patens*, 8 Apr 1999, *Rosen & Jones 840* (NO). **Texas**. Calhoun Co.: S of Hwy. 185, 4.1 mi E of Seadrift, occurs in a few clonal stands in roadside ditch with *Sagittaria* sp., *Nymphaea* sp., *Cyperus haspan*, *Ludwigia* spp., *Bacopa* sp., *Echinodorus* sp., *Rhynchospora* spp., *Spartina patens*, *Eleocharis cellulosa*, *Schoenoplectus pungens*, and *Mitreola* sp., 24 Jul 2004, *Rosen & Combs 3017* (NY, TEX). Galveston Co.: Coastal pimple mound prairie S of Hitchcock, ca. 2.7 mi S of the intersection of Hwy 6 and FM 2004, occasional in shallow water and on mud along irrigation canal and ditches that bisect the prairie, with *Eleocharis quadrangulata* and *E. cellulosa*, 19 Aug 2004, *Rosen & Schubert 3052* (BRIT, SBSC, TEX, VDB). Jefferson Co.: on and E of private gravel ranch road, ca. 3 km S of Wilber Rd, near the Big Hill Oil Field, a strongly rhizomatous perennial forming large stands in coastal wetlands with *Spartina patens*, *Cyperus* spp., *Schoenoplectus californicus*, *Eleocharis quadrangulata*, *E. cellulosa*, *Rhynchospora corniculata*, *Ludwigia* sp., *Sagittaria lancifolia*, and *Typha latifolia*, 28 Aug 2007, *Rosen 4399* (TEX, MICH, US).

Figure 2. Second author near clonal stand of *Eleocharis* ×*inaequilatera* at the type locality.

Eleocharis* subg. *Limnochloa

Eleocharis cellulosa and *E. quadrangulata* belong to subg. *Limnochloa*, a group of over 35 species distributed throughout tropical and subtropical regions worldwide, most being robust emergent plants forming extensive stands in wetlands. Species in the subgenus are readily distinguished from other spikerushes by a combination of cartilaginous floral scales with prominent longitudinal veins, culms that are usually as thick as the cylindrical spikelets, and biconvex (or rarely trigonous) achenes with usually large polygonal epidermal cells arranged in longitudinal rows (González-Elizondo & Peterson 1997). Identification of species in this group relies on features of

mature achenes, such as shape and arrangement of the pericarpial cells and the persistent style base (or tubercle), and secondarily on culm cross-sectional shape, which ranges from 3-5 sharp angles to terete.

Hybridization in spikerushes

Hybridization in spikerushes in North America is probably not uncommon but is likely under-reported. A few hybrid spikerushes have been described on the basis of sympatry of their parents and intermediacy of morphological characters (Catling & Hay 1993; Catling 1994) and additionally utilizing DNA markers in hybrids involving *Eleocharis cellulosa* (Košnar et al. 2010). In all of these hybrids, emphasis is placed on characteristics of the achene (a rich source of data absent in our new sterile hybrid). However, characteristics of culm cross-sectional shape are intermediate between the putative parent species of *E. compressa* Sull.× *E. erythropoda* Steud. (Fig. 5 in Catling 1994).

Formation of *Eleocharis ×inaequilatera*

Eleocharis cellulosa and *E. quadrangulata* are sympatric in Alabama, Arkansas, Florida, Goergia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. Evidence supporting the hybrid origin of *E. ×inaequilatera* includes its occurrence at multiple locations of parental sympatry and culm cross-sectional shape immediately below the spikelet that is intermediate between the obscurely 3-angled to sub-trigonous *E. cellulosa* and the acutely and unequally quadrangular *E. quadrangulata* (Fig. 3). In *E. ×inaequilatera* and *E. quadrangulata* there are five conspicuous vascular bundles embedded in aerenchymatous tissue, compared to three in *E. cellulosa* (Fig. 3). *Eleocharis ×inaequilatera* could easily be misidentified as the triquetrous stemmed *E. acutangula* (Roxb.) Schult. or *E. mutata* (L.) Roem. & Schult. (*Rosen & Jones 840* is annotated by a botanist as *E. acutangula*) as the fourth angle in *E. ×inaequilatera* is sometimes scarcely noticeable in the field or herbarium specimens. Plants with a more defined fourth angle might be misidentified as *E. quadrangulata*.

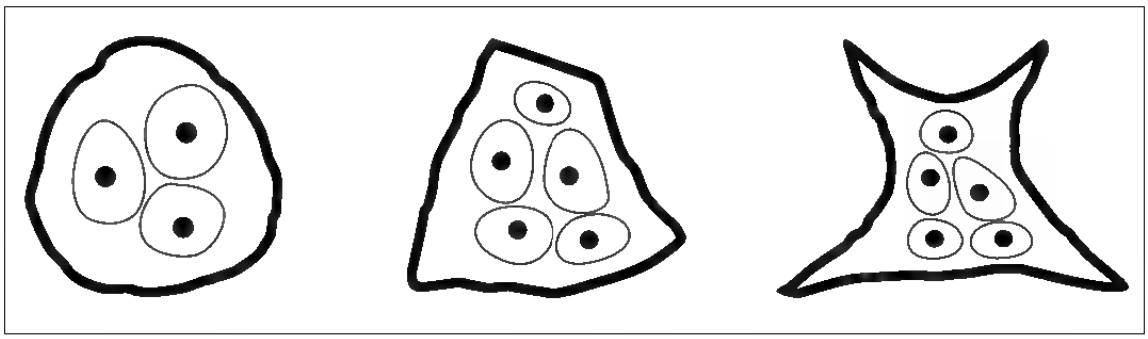

Figure 3. Comparison of culm cross-sectional shape and vascular bundle arrangement immediately below the spikelet of (left) *Eleocharis cellulosa*, (center) *E. ×inaequilatera*, and (right) *E. quadrangulata*

The morphology of *Eleocharis ×inaequilatera* from all sites appears quite consistent. Several sites visited repeatedly over time by the first author saw a decrease in cover of *E. cellulosa* and *E. quadrangulata* and an increase of *E. ×inaequilatera* by asexual reproduction. Rapid spread by rhizomes of *E. ×inaequilatera* may quickly reduce cover of the parental species resulting in extensive clonal stands (Fig. 2). Other hybrid plants have been shown to exhibit superior fitness over the parental species at the point of contact (Arnold & Hodges 1995). The type locality (Fig. 2) presents an almost ideal field experiment, as it is a small (ca. 1 ha), ephemeral, freshwater pond where the hybrid covers approximately 30% of the area and both parents occur in small clumps on the edge of the clonal stand (Fig. 2).

Both parental species are ecologically important, often forming extensive stands where they provide cover and food for wetland wildlife (personal observation by the authors). The resulting hybrid seemingly outcompetes the parents, which might affect habitat structure and wildlife value. More field and greenhouse studies investigating the hybrid's competitive vigor and its potential impact on biodiversity would be important.

ACKNOWLEDGEMENTS

We thank Riceland Lumber Company and Larson & McGowin Forest Managers and Consultants for allowing access to the type locality. We are grateful to Tom Wendt for providing an image of the holotype, Neva Mikulicz for preparing Figure 2, and Richard Carter and Guy Nesom for their helpful reviews of our manuscript.

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Published 15 April 2015. ISSN 2153 733X

EUPHORBIA ABRAMSIANA (EUPHORBIACEAE): NEW TO TEXAS

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ABSTRACT

Euphorbia abramsiana L.C. Wheeler is a prostrate annual found throughout southern California, Arizona, the southwest corner of New Mexico, and adjacent Mexico. This report documents its occurrence in trans-Pecos Texas. Misidentified *E. abramsiana* specimens, mostly confused with *E. glyptosperma* and *E. serpyllifolia*, have been found from locations mainly in and near Big Bend National Park and Big Bend Ranch State Park. *Euphorbia abramsiana* differs from *E. glyptosperma* and *E. serpyllifolia* by the presence of very short, stiff hairs on the stems, distinct pale lines following the pattern of the pinnate venation on the leaf blades, leaf blade maculation consisting of a series of spots along and near the midvein, and an abrupt protrusion on the chalazal end of the seed.

Euphorbia abramsiana L.C. Wheeler (subg. *Chamaesyce* sect. *Anisophyllum*) is a prostrate desert annual (Fig. 1) previously known from southern California, Arizona, the southwestern corner of New Mexico, and adjacent Mexico. The species is now documented for Texas, represented by eight specimens in the Sul Ross State University Herbarium (SRSC) and two from the University of Texas herbarium (TEX-LL). All were collected in and near Big Bend National Park (BBNP) and Big Bend Ranch State Park (BBRSP), with one seemingly out-of-place record in Reeves County (Fig. 3).

Texas specimens of *Euphorbia abramsiana* examined. Reeves Co.: Frequent annual; limestone soil along highway about 15 mi S of Pecos toward Saragosa, alt. 457 m, 9 Sep 1951, *Warnock 10181* (TEX-LL). Presidio Co.: BBRSP, Terneros Creek crossing on road to Sauceda, 579814 E, 3269720 N, alt. 920 m, 30 Sep 2014, *Morey 207* (SRSC); BBRSP, Madera Canyon River Access, near 605018 E, 3240801 N, alt. 720 m, 22 Sep 2014, *Morey 197* (SRSC; Fig. 1); BBRSP, 1 mi W of Lajitas on Rio Grande, 616973 E, 3237502 N, 710 m, 23 Sep 2014, *Morey 198* (SRSC); 6.1 km N of Presidio on Hwy 67, 4 Sep 1999, *McRae 41* (SRSC). Brewster Co.: BBNP, Mesa de Anguila Trail, off trail just E of Comanche Creek, 27 Sep 2014, *Morey 203* (SRSC); BBNP, frequent annual on sandy soil at head of Boquillas Canyon, alt. 579 m, 12 Aug 1966, *Warnock 20951* (SRSC); BBNP, gravel-topped yellow marl hills near San Vicente, 29°9' x 103°1', alt. ca. 579 m, 16 Nov 1958, *Johnston 3625* (SRSC); BBNP, infrequent annual in limestone soil in Avery Canyon, alt. 975 m, 23 July 1950, *Warnock 9135* (SRSC); BBNP, muddy banks of Rio Grande near San Vicente, 26 Aug 1915, *Young s.n.* (TEX-LL).

Description of Texas specimens of *Euphorbia abramsiana*. Prostrate to ascending annual; stems pubescent with very short, stiff hairs, at least basally, often glabrous toward the apices; leaf blades oval to oblong, oblong-ovate, oblong-lanceolate (often the short side is semi-oval and the long side is semi-oblong), to 10 mm long, 4 mm wide, sometimes pubescent, bases unequal; blades green in shade to dark green in bright sunlight in living plants, with pale stripes following the pattern of the

pinnate venation (though not veins themselves; stripes fade after blades dry); blade maculation comprised of a series of spots, usually of different sizes, arranged along and near the midrib (spots sometimes branching or merging to form an irregular shape), or occasionally 1 or a few spots along and near major veins away from the midrib; blade margins entire to toothed at the apex and along the long side of the margins; stipules divided several times into filaments; cyathia solitary at the nodes; involucral glands mostly circular, occasionally oblong, with appendages entire to bilobed; involucral lobes between glands usually divided into a few segments; staminate flowers 3–5; styles divided and short; capsules globose triangular, slightly elongated, 1.8 mm long, 1.5 mm wide, glabrous; seeds quadrangular in cross section, white, 1.2–1.3 mm long, ca. 0.5 mm wide, with markedly raised, rounded transverse ridges, with the angles appearing entire or inconspicuously notched between some transverse ridges, the transverse ridges appearing mostly continuous with the angles, and the chalazal end of the seed with an abrupt protrusion, less than 0.1 mm long.

The description above of *Euphorbia abramsiana* is mostly consistent with others published for the species (Jercinovic 2007; Wheeler 1934; Wheeler 1941), but we have provided more details here on leaf morphology and seeds. Steinman and Felger (1997) described minute teeth on the margins of the leaf blade large enough to be seen only with aid of magnification, compared to *E. serpyllifolia* with conspicuous teeth often large enough to be seen without magnification. We find that *E. abramsiana* can have larger teeth than *E. serpyllifolia*, albeit rarely. Apart from some specimens with relatively deep incisions between the teeth, the Texas specimens cited above display all other characters of *E. abramsiana*. The Texas specimens also look very similar to an isotype (*Abrams 4097*, MO, digital image via tropicos.org).

Figure 1. *Euphorbia abramsiana*. *Morey 197*, Madera Canyon River Access, Big Bend Ranch State Park, Texas, 22 Sep 2014. Photo by Roy Morey, used with his permission.

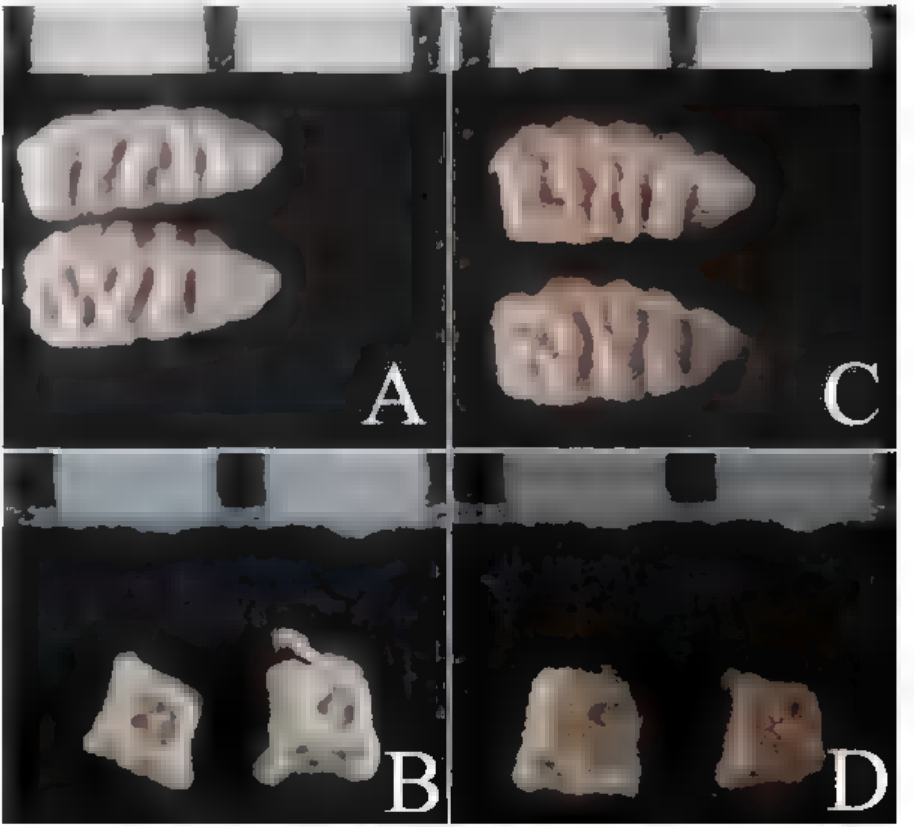

Figure 2. A. *Euphorbia abramsiana* seeds have transverse ridges appearing mostly continuous with the rest of the seed; angles (four corners of seeds in cross section) less noticeably notched between ridges (*Warnock 9135*, SRSC). B. Chalazal end of *E. abramsiana* seed showing a protrusion often visible from the side of the seed (*Warnock 9135*, SRSC). C. *Euphorbia glyptosperma* seeds have transverse ridges that appear distinct from the areas between notches and often appear as a slightly different color; angles noticeably notched between ridges (*Warnock & Parks 8762*, SRSC). D. Chalazal end of *E. glyptosperma* seed mostly flat or only slightly bulging and not typically visible from the side of the seed (*Warnock & Parks 8762*, SRSC). Seed differences between *E. abramsiana* and *E. glyptosperma* are somewhat inconsistent in ridge characters but consistent in characters on the chalazal end of seeds, at least in specimens collected in the Trans-Pecos. Scale in millimeters.

The *Euphorbia abramsiana* specimens from Texas were previously identified as *E. glyptosperma* (Fig. 5), *E. serpyllifolia* (Fig. 6), and one as *E. golondrina*, with four specimens bearing annotations by M.C. Johnston. Johnston annotated these specimens as "atypical" and belonging to *E. glyptosperma*. Correll and Johnston (1970) similarly noted that some "aberrant" specimens of *E. glyptosperma* are pubescent. *Euphorbia glyptosperma* and *E. serpyllifolia* are both common throughout trans-Pecos Texas. *Euphorbia glyptosperma* is found throughout Texas except in the eastern part of the state (Fig. 3) and seems to prefer sandy, disturbed soils, whereas *E. serpyllifolia* is seemingly restricted to the Trans-Pecos and is found mostly in rocky soils. In the USA as a whole, *E. glyptosperma* and *E. serpyllifolia* are reported throughout except the southeastern states (even

entering Canada). *Euphorbia golondrina* is restricted to trans-Pecos Texas and is much less widespread, apparently confined to certain sandy habitats. *Euphorbia abramsiana*, *E. glyptosperma*, *E. serpyllifolia*, and *E. golondrina* are sympatric in trans-Pecos Texas.

Many *Euphorbia glyptosperma* specimens from the Trans-Pecos differ slightly in certain characters from *E. glyptosperma* specimens from other parts of Texas (Fig. 5). In many Trans-Pecos specimens of *E. glyptosperma* the seeds are longer, the leaf blades are usually more oval, bases of blades are less unequal, the cyathial glands are more circular, and the glandular appendages are more often 2-lobed. All these traits approach those of *E. abramsiana*, suggesting hybridization between these two species in the Trans-Pecos region where they are sympatric.

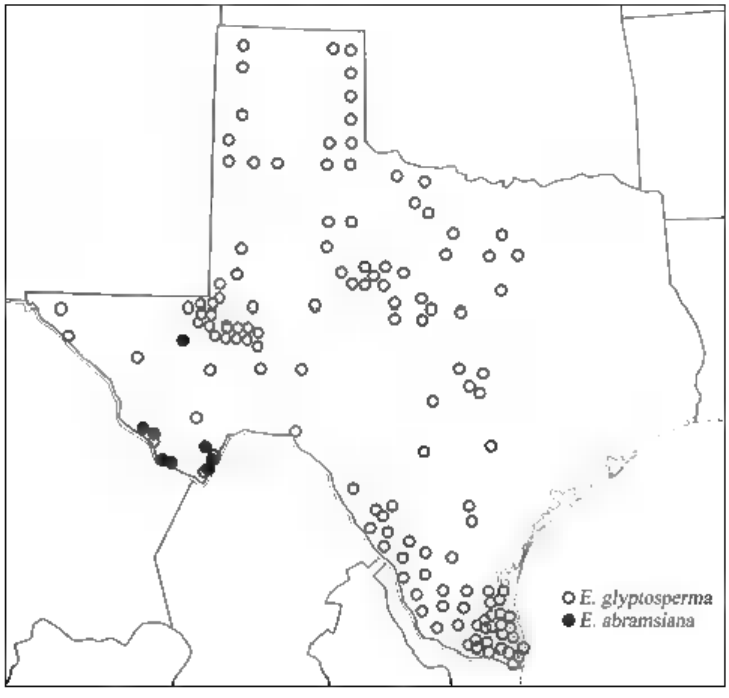

Figure 3. Distribution of *Euphorbia abramsiana* and *E. glyptosperma* in Texas (distribution of *E. glyptosperma* outside trans-Pecos Texas from Turner et al. 2003).

Key to *Euphorbia abramsiana* and similar species

1. Upper stipules (those on the side of the stem facing upward or mostly upward) not united and mostly entire, forming 2 linear segments; lower stipules (those on the side of the stem facing downward or mostly downward) united into a single linear segment; seeds greater than 1.5 mm long, lacking markedly raised transverse ridges ..... **Euphorbia golondrina**
1. Upper and lower stipules divided, often into more than 2 linear segments; seeds less than 1.5 mm long, with or without transverse ridges.
    2. Stems usually ascending and somewhat winged, giving the plant a shriveled appearance; seeds smooth, pitted, wrinkled, or with low transverse ridges (Fig. 6) ..... **Euphorbia serpyllifolia**
    2. Stems prostrate (except in shade or dense competition with other plants), not winged; seeds with markedly raised transverse ridges.

3. Stems pubescent with short stiff hairs (often only basally); leaf blades often with pale stripes following the pattern of the pinnate venation in living plants; maculation interrupted, consisting of many small circular or irregular spots (Fig. 4); seeds concolorous, white; seeds with a protrusion at the chalazal end (Fig. 2A) ..... **Euphorbia abramsiana**

3. Stems glabrous; leaf blades lacking pale stripes; maculation rarely present but, if present forming a single, continuous, linear spot along the midvein; seeds often slightly bicolorous when mature, with mostly light tan ridges and slightly paler areas (sometimes with a pale reddish tint) between ridges; seeds without a protrusion at the chalazal end (Fig. 2B) ..... **Euphorbia glyptosperma**

Figure 4. *Euphorbia abramsiana*. Leaf blades often have pale lines in the position of pinnate venation and a central splotch broken into many smaller spots. A. Hot Springs Trail, Big Bend National Park, Texas, 12 Oct 2014. B. Tucson, Arizona, 7 Aug 2014.

Figure 5. *Euphorbia glyptosperma*. Leaf blades without lines or splotches. *Euphorbia glyptosperma* specimens from the Trans-Pecos often display characteristics similar to those of *E. abramsiana*, compared to *E. glyptosperma* specimens in other parts of Texas. A. Tornillo Creek, Big Bend National Park, Texas, 12 Oct 2014. B. Gaines Co., Texas, 5 Oct 2011.

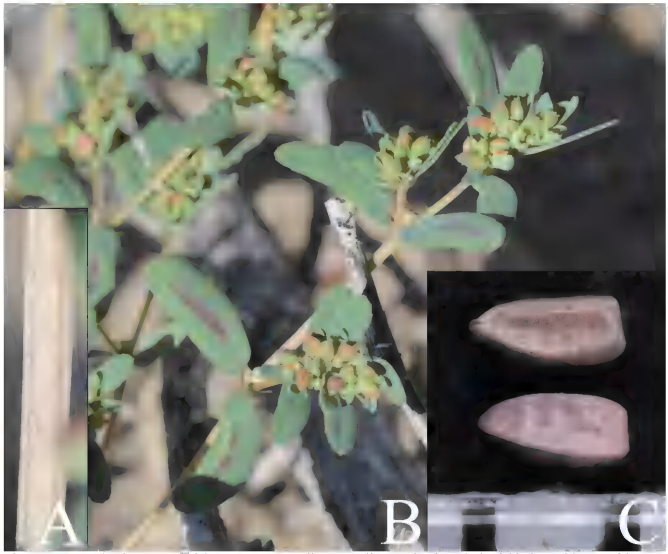

Figure 6. *Euphorbia serpyllifolia*. Stems usually ascending and winged; leaf blades with or without a continuous, linear splotch; seeds pitted, wrinkled, or with low transverse ridges. A. and B. Tornillo Creek, Big Bend National Park, Texas, 12 Oct 2014. C. Solitario Overlook, Big Bend Ranch State Park, Texas, 4 Sep. 2014, *Morey 182*. The distance between the two wide black vertical lines at bottom of figure is 1 millimeter.

ACKNOWLEDGEMENTS

We thank A. Michael Powell for providing valuable comments that improved this paper and for providing continual access and use of the Sul Ross State University Herbarium. We acknowledge Tom Wendt and Billie Turner for welcoming access to the University of Texas Herbarium. We also thank Guy Nesom for improvements made to this paper.

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PHLOX SOLIVAGUS (POLEMONIACEAE), A NEW SPECIES FROM THE BLUE MOUNTAINS IN SOUTHEASTERN WASHINGTON

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ABSTRACT

A new species of *Phlox* is described from a series of peaks and ridgetops in the Blue Mountains of southeastern Washington state. **Phlox solivagus** M. Mayfield & M. Darrach, **sp. nov.**, is narrowly restricted to exposed rocky sites and flowers in mid–late spring when easy access by collectors can be obstructed by snow on surrounding slopes. This species is a highly distinctive caespitose perennial *Phlox* with lanate vestiture on stems and leaves, thickened leaves with involute margins (yielding a prow-shaped apex), and inflorescence herbage densely covered with gland-tipped trichomes. The new *Phlox* is described and discussed with respect to species to which it is similar, and a key to *Phlox* species of the northern Blue Mountains is provided.

Phlox is a genus of ca. 60 species chiefly occurring in North America, with a center of diversity in western North America (Wherry 1955; Locklear 2011). It is rich in species in the Pacific Northwest, particularly through the ecologically diverse area from eastern Oregon and Washington to western Montana. Near the northern terminus of the Blue Mountains in southeastern Washington and northeastern Oregon, six *Phlox* species occur that have broader distributions in the western USA: *P. douglasii* Hook. (sensu Locklear 2009; sometimes synonymized with *P. caespitosa* Nutt.), *P. hoodii* Richardson, *P. longifolia* Nutt., *P. multiflora* A. Nelson, *P. speciosa* Pursh, and *P. viscida* E.E. Nelson (which is restricted to the region; Ferguson et al., in prep. for FNANM). *Phlox colubrina* Wherry & Constance is a narrow endemic occurring slightly farther east in Hells Canyon of the Snake River and along its major tributaries.

Recent botanical explorations in the northern Blue Mountains have brought to light a new, narrowly endemic species. It appears most similar morphologically to the more open and erect *Phlox mollis* Wherry, another narrowly distributed species that occurs across the Snake River in Nez Perce County, Idaho, on and around Craig Mountain. Here we describe the new species and discuss current

knowledge of its distribution and ecology, setting the stage for further investigation of this intriguing species. Material of the new species is included in genetic research currently underway for the genus *Phlox* (CJF et al.).

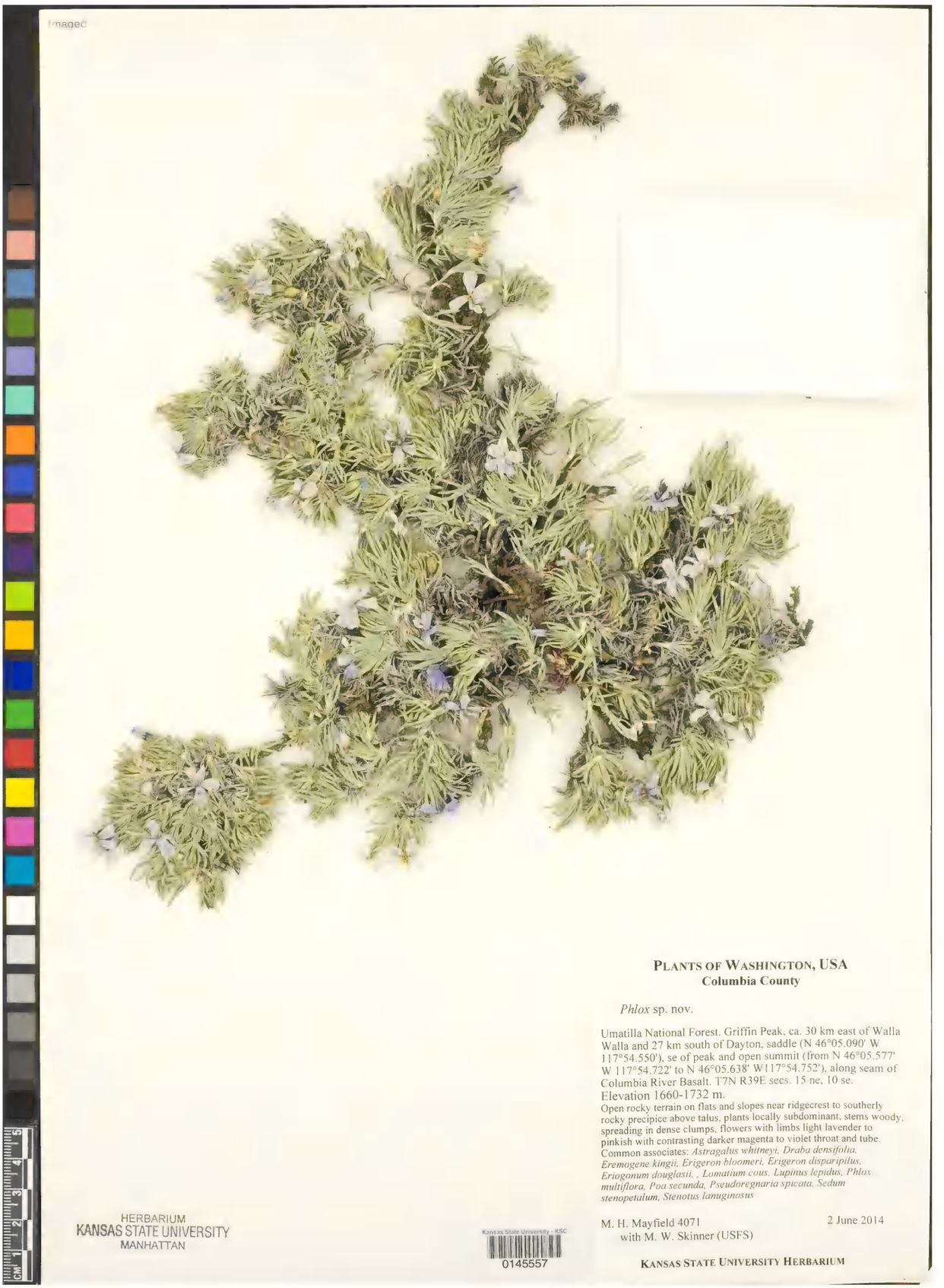
PHLOX SOLIVAGUS M. Mayfield & M. Darrach, **sp. nov. TYPE: USA. Washington.** Columbia Co.: Umatilla National Forest, Griffin Peak, ca. 30 km E of Walla Walla and 27 km S of Dayton, saddle (N 46° 05.090' W 117° 54.550'), SE of peak and open summit (N 46°05.577' W 117° 54.722' to N 46° 05.638' W 117°54.752'), along seam of Columbia River Basalt, T7N R39E secs. 15 ne, 10 se, elev. 1660-1732 m, open rocky terrain on flats and slopes near ridge crest to southerly rocky precipice above talus, plants locally subdominant, stems woody, spreading in dense clumps, flowers with limbs light lavender to pinkish with contrasting darker magenta to violet throat and tube, common associates *Astragalus whitneyi, Draba densifolia, Eremogone kingii, Erigeron bloomeri, Erigeron disparipilus, Eriogonum douglasii, Lomatium cous, Lupinus lepidus, Phlox multiflora, Poa secunda, Pseudoroegneria spicata, Sedum stenopetalum,* and *Stenotus lamuginosus*, 2 Jun 2014, *M.H. Mayfield 4071* with M.W. Skinner (holotype [Fig. 1]: KSC, barcode 145557; isotypes: ID, MSC, NY, OSC, RM, US, WS, WTU, and the Umatilla National Forest Herbarium, Pendleton, Oregon). Figures 1–6.

Similar to *Phlox mollis* Wherry in the densely lanate leaves and prow-shaped leaf apices but differing notably in its more compact habit and copiously glandular calyx.

Perennial herbs forming dense mounds or tufts, with many stems spreading from a woody base, 3–7 cm. **Stems** of the season erect, with 5–7 nodes, vestiture arachnoid, vegetative stems morphologically similar to flowering stems. **Leaves** opposite, midvein abaxially prominent and adaxially visible, secondary veins not visible, narrowly lanceolate to linear, apex pungent, the longest 8–20 mm x 1–2 mm, lanate (rendering a gray-green appearance to herbage), margins thickened and involute (yielding a prow-shaped apex), marginal hairs not strongly distinct. **Flowers** usually solitary, or in a cyme of 2–3 flowers; pedicels 1–5 mm. **Calyx** campanulate, the tube with 5 thicker, green sepals joined to near the midpoint by intervening thin, translucent membranes, externally densely pubescent with the trichomes gland-tipped, with lobes internally lanate toward tips, lobes 9–14 mm, midveins discernible to near the pungent tips, membranes flat. **Corolla** funnelform with a slender tube and 5 abruptly spreading lobes, lavender pink, usually with darker purplish-magenta markings near the tube orifice, tube 11–13 (15) mm, glabrous, unconstricted, flaring slightly near orifice, the lobes 6–11 mm, obovate, apically rounded. **Stamens** unequally inserted in tube, anthers ca 1.8 mm, yellow, distal-most near orifice. **Pistil** of 3 fused carpels, the ovary with 1 ovule per locule, the style 5–7 mm, the 3 stigma branches 0.8–1.3 mm, included within the tube and among lowermost anthers. **Fruits** 3-seeded, seeds ca. 3 mm. **Phenology**: flowering mid May–early June.

Etymology. The epithet refers to the isolated, "lonely" nature of the windswept populations of *P. solivagus*. Occurrences of the species have rarely been visited by botanists during the flowering phase of the plant's phenology and thus the plants have largely escaped attention. The suggested common name is "yeti phlox," in reference to the hairy leaf vestiture.

Paratypes. **USA. Washington.** Columbia Co.: Lewis Peak, Blue Mountains, 27-29 May 1923, *Brode 14* (WS); Umatilla National Forest, Blue Mountains, SE edge of Griffin Peak, ca 19 air mi E of Walla Walla, T7N R39E S10 SE1/4, grass-forb community with *Elymus spicatus* [*Pseudoroegneria spicata*], *Festuca idahoensis*, *Poa secunda*, *Lomatium cous*, and *Sedum stenopetalum*, elev. 5650 ft, 5 Jun 2003, *Markow 12466* (KSC, topotype); Blue Mountains, summit of Squaw Peak, 1.5 air km E of Table Rock, elev. 1813 m, 46.03053°N, 117.89171°W (uncertainty: 6 m.; Datum: WGS 84; Source: GPS), windswept, treeless pinnacle with gently sloping sides, broken basalt and dry gravelly soil at summit, with low cushions of *Eriogonum ovalifolium* [*E. flavum* var. *piperi*], *Phlox* sp., *Sedum lanceolatum*, *Draba densifolia*, *Poa secunda*, and *Festuca*, leaves gray- green, with two rows of woolly-pubescence on lower surface, mostly non-glandular, plants forming loose, low mats to 40 cm in diameter from a stout taproot,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PLANTS OF WASHINGTON, USA
Columbia County
Phlox sp. nov.
Umatilla National Forest. Griffin Peak, ca. 30 km east of Walla Walla and 27 km south of Dayton, saddle (N 46°05.090' W 117°54.550'), se of peak and open summit (from N 46°05.577' W 117°54.722' to N 46°05.638' W117°54.752'), along seam of Columbia River Basalt. T7N R39E secs. 15 ne, 10 se.
Elevation 1660-1732 m.
Open rocky terrain on flats and slopes near ridgecrest to southerly rocky precipice above talus, plants locally subdominant, stems woody, spreading in dense clumps, flowers with limbs light lavender to pinkish with contrasting darker magenta to violet throat and tube.
Common associates: Astragalus whitneyi, Draba densifolia, Eremogene kingii, Erigeron bloomeri, Erigeron disparipilus, Eriogonum douglasii, , Lomatium cous, Lupinus lepidus, Phlox multiflora, Poa secunda, Pseudoregnaria spicata, Sedum stenopetalum, Stenotus lanuginosus
M. H. Mayfield 4071
with M. W. Skinner (USFS)
2 June 2014
KANSAS STATE UNIVERSITY HERBARIUM
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Figure 1. *Phlox solivagus* holotype (KSC).

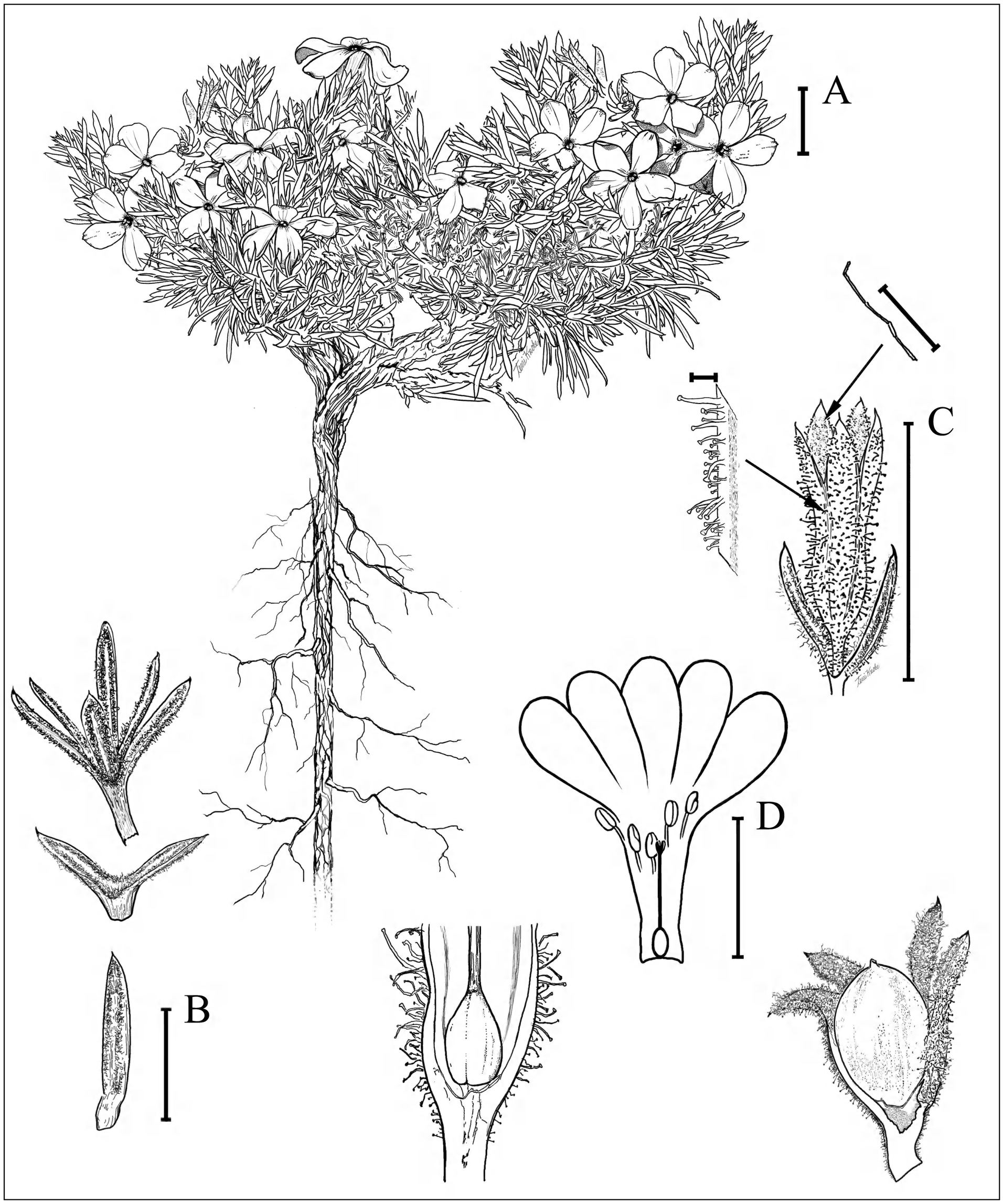

Figure 2. *Phlox solivagus* illustration. A) Habit (scale bar, 1 cm). B) Leaves, top to bottom: cluster at growing tip; pair of leaves; single leaf, adaxial view (scale bar, 10 mm). C) Calyx (scale bar, 10 mm), with detail on vestiture: left, portion of sepal, bearing gland-tipped trichomes, and part of membrane between sepals (scale bar, 1 mm); above, eglandular trichome from inner tip of sepal (scale bar, 1 mm). At bottom are shown a cutaway view of ovary in calyx (with corolla removed); and cutaway view of developing fruit (with style senesced). D) Outline view of opened corolla showing positions of reproductive parts (scale bar, 10 mm).

Figure 3. *Phlox solivagus* habit. Image was taken at the type locality, vicinity of Griffin Peak, Columbia Co., Washington. An individual of *P. multiflora*, which co-occurs at this site, is visible at top left. Image © Mark H. Mayfield.

locally abundant at immediate windswept summit where little snow appears to accumulate in winter, 5 Jul 2014, *B. Legler 13074* with S. Legler (WTU, KSC). Garfield Co.: Blue Mountains, gentle summit of Cape Horn Ridge, fairly abundant, but restricted to nearly flat aspect, elevation 4458 ft (1359 m), 46.257778°N, 117.438694°W (uncertainty: +/- 2.3 m.; datum NAD83; source: GPS), open, windswept Columbia River Basalt Group entablature surface, aspect 112°, slope 5%, associated species *Balsamorhiza serrata, Castilleja thompsonii, Lomatium piperi, Phlox hoodii, Poa secunda,* and *Pseudoroegneria spicata,* 29 Jun 2013, *Darrach 1021* with Brumbelow and Gibble (KSC); Blue Mountains, Umatilla National Forest: open rocky flat ridgetop of Cape Horn Ridge, along FS road 4106100, central part of western edge of sec 16, T9N R43E, 46°15.47' N, 117°26.32 W, elevation 4450 ft (1360 m), associated species *Allium tolmiei, Balsamorhiza serrata, Castilleja thompsonii, Erigeron disparipilus, Poa secunda,* and *Pseudoroegneria spicata,* plants scattered, common, flowers white to pale pink with darker magenta throat and tube, 28 May 2014, *Mayfield 4057* with Darrach & Brumbelow (KSC, RM, WS, WTU); Blue Mountains: gentle summit of Cape Horn Ridge, abundant, but restricted to flat aspect, elevation 4454 ft (1358 m), UTM NAD 83 11N 466181, 5122781 (+/- 2.1 m.; source: GPS), aspect flat, substrate basalt lithosol, associated species *Allium tolmiei, Balsamorhiza serrata, Castilleja thompsonii, Erigeron disparipilus, Penstemon humilis, Poa secunda, Pseudoroegneria spicata,* 28 May 2014, *Darrach 1059* with Mayfield & Brumbelow (Umatilla National Forest Herbarium, Pendleton, Oregon).

Figure 4. Habitat of the new species on rocky, sparsely vegetated slopes at the type locality on the north side of Griffin Peak (Columbia Co., Washington). Flowering individuals of *P. solivagus* (lavender pink corollas, gray-green herbage) are visible throughout the image (with one plant obvious in the lower right quadrant of the image; some individuals of *P. multiflora* [white corollas, green herbage] are also visible in this area). Image © Mark H. Mayfield.

Figure 5. Flowering stems of *P. solivagus* (note that numerous other taxa are visible in the image). Image was taken at the Cape Horn Ridge site, Garfield Co., Washington. Image © Mark H. Mayfield.

Figure 6. *Phlox solivagus* individual with senescing flowers and developing fruits (Cape Horn Ridge, Garfield Co., Washington). Image © Mark H. Mayfield.

Distribution and ecology

Phlox solivagus has been most recently documented from three populations in the northern Blue Mountains of Washington state: Griffin and Squaw Peaks in Columbia County, and Cape Horn Ridge in Garfield County. The Lewis Peak locality represented by the paratype collection of M.D. Brode from 1923 has not, to date, been revisited by the authors, and it is not known if the population is still extant. It is not clear from the original label data whether the collection was made on what is now private, possibly developed land, or Bureau of Land Management (BLM) property.

The locations of the type collection at Griffin Peak and the paratype collection from Squaw Peak are quite close to the Oregon state border. Potentially suitable habitat occurs over the state line in Oregon and searches throughout the area should be conducted to ascertain possible presence.

There are possibly additional sites that harbor *Phlox solivagus* in similar habitats in the northern Blue Mountains of Washington. However, we do not expect the species to be found in great abundance beyond the already known localities. Workers on the Umatilla National Forest have historically paid close attention to plant diversity and are well aware of the heterogeneous habitats of the region. Given this and the distinctive appearance of *P. solivagus* at all times during the field season (whether reproductive or not), recent observations by Forest Service workers with knowledge of the new species have not turned up additional sites. All of the recently documented populations (all populations except that represented by the historical Lewis Peak collection) are on public lands of the Umatilla National Forest, and future survey efforts should focus intensively on sites within the forest boundaries — although searching for populations on adjacent private and BLM land holdings will also be necessary in order to fully ascertain the distribution of the species.

Phlox solivagus occurs in discrete clumps or as isolated individuals that tend to be a subdominant element of the associated immediate plant community. Locally, for example in the Squaw Peak population, *P. solivagus* can be a dominant species from a percent cover standpoint. Studies at the Griffin Peak population estimate densities of 1.8 plants per m^2 (over a total of 98 contiguous plots evaluated; MED, unpubl. data). In the area of Cape Horn Ridge, plants are observed to occur beyond the primary collection site on three nearby ridges (with some discontinuity; MED, unpubl. data; this site is hereafter referred to as a metapopulation). The sum total number of individuals occurring at the Griffin Peak, Squaw Peak and the Cape Horn Ridge sites is estimated at 2000–3000 individuals. Careful observations by several botanists to date indicate that these populations may be in decline: most individuals in all populations are observed to be mature and many are clearly senescing, while plants interpreted as younger are either not evident or very uncommon.

Conservation measures that should be considered for *Phlox solivagus* include a long-term trend monitoring program and in particular a concerted effort to search for additional populations. In this regard a sense of how broadly the species may be distributed is of value. The Griffin Peak population and the Cape Horn Ridge metapopulation are separated from each other by approximately 45 air kilometers. This distance also encompasses a precipitation gradient that declines northeastward from a 30-year moving average of 142–152 water equivalent cm per year at Griffin Peak to approximately 51–71 water equivalent cm per year at Cape Horn Ridge and adjacent xeric ridge systems. This broad gradient suggests that *P. solivagus* may have a similarly broad ecological amplitude and may therefore potentially occupy a sizeable geographical area where appropriate flat to gently-sloping exposed rocky habitats exist.

Phlox solivagus appears to be restricted to erosional paleosurfaces that include what are interpreted to be modified Pleistocene remnant plant communities — this may be particularly informative to the search for additional populations. All of the known occurrences, and in particular

those sites in the Cape Horn Ridge metapopulation, are clearly restricted to a flat to very gently easterly aspect, regionally-extensive erosional paleosurface. These surfaces are typically very limited in areal extent and may serve as refugia that support a unique relict plant community apparently found nowhere else in an otherwise highly dissected, erosionally active landscape. At the type locality and the nearby Squaw Peak population, elements of the plant community also suggest a highly modified low alpine vegetation zone influence, with alpine lichen taxa such as *Ochrolechia upsaliensis* being present. This observation is in concordance with vegetation patterns observed elsewhere in the general area. Plants of *P. solivagus* are almost completely absent on the erosionally active landforms adjacent to the gentle paleosurface sites.

Species documented to co-occur with *Phlox solivagus* include *Allium tolmiei*, *Astragalus whitneyi*, *Boechera sparsiflora*, *Balsamorhiza serrata*, *Castilleja thompsonii*, *Draba densifolia*, *Draba verna*, *Elymus elymoides*, *Epilobium brachycarpum*, *Eremegone kingii* var. *glabrescens*, *Erigeron bloomeri*, *Erigeron disparipilus*, *Eriogonum douglasii* var. *douglasii*, *Eriogonum flavum* var. *piperi*, *Eriogonum heracleoides*, *Eriogonum umbellatum* var. *ellipticum*, *Festuca idahoensis*, *Lomatium cous*, *Lomatium macrocarpum*, *Lupinus lepidus* subsp. *aridus*, *Lupinus sulphureus*, *Microsteris gracilis*, *Ochrolechia upsaliensis*, *Olysnium douglasii* var. *inflatum*, *Penstemon humilis*, *Penstemon pennellianus*, *Penstemon venustus*, *Phlox hoodii*, *Phlox multiflora*, *Poa secunda* subsp. *secunda*, *Pseudoroegneria spicata* var. *spicata*, *Pyrrocoma carthamoides*, *Sedum stenopetalum*, *Selaginella wallacei*, *Silene douglasii*, and *Stenotus lanuginosus*.

Discussion

Material of the new species was first brought to the attention of the first author by Stuart Markow, a Forest Service botanist serving on the Umatilla National Forest in the early 2000s. Markow observed the Griffin Peak population (now the type locality), collected a specimen and sent it to CJF, who had not encountered similar material from the Blue Mountains during studies of *Phlox*. CJF and MHM, in work on the *Phlox* treatment for the *Flora of North American North of Mexico*, had noted similarity of the Markow specimen to *P. mollis* (discussed below) and filed the unicate specimen as "aff. *P. mollis*" pending further study. The second author, MED, discovered the Cape Horn Ridge metapopulation on 29 June 2013 and recognized the plants as unusual (despite their being past flower). He collected material and sent it to CJF. This latter discovery matched the Markow specimen and underscored the unique morphology of these populations, spurring June 2014 field research by MED and MHM along with USDA Forest Service Regional Botanist Mark Skinner. MHM additionally located an historical specimen, *Brode 14* (WS, collected in 1923). Interestingly, this latter specimen had been annotated in the 1940s as a possible new taxon by Edgar T. Wherry, the most recent monographer of *Phlox*, although he did not describe it nor explicitly discuss the specimen in his treatment of the genus (Wherry 1955). Botanist B. Legler (University of Washington, Burke Museum [WTU]) discovered the Squaw Peak population in July 2014 and Forest Service personnel have continued to seek out additional occurrences of the new species.

Early in our study, the very dense, woolly vestiture of *Phlox solivagus* suggested an evolutionary affinity with *P. mollis*, a narrowly endemic taxon occurring some 50 km to the east-southeast, across the Snake River in western Idaho. However, whereas the inflorescence of *P. solivagus* bears glandular trichomes, *P. mollis* lacks glandular hairs entirely. Moreover, *P. mollis* differs in its upright (vs. mounded) habit with taller stems and well-spaced nodes and in its larger leaves and larger floral measurements. In fact, *P. mollis* is similar in habit to upright western taxa including *P. longifolia* Nutt. and *P. viscida* E.E. Nelson. Interestingly, Wherry (1955) noted *P. mollis* as "reported from Blue Mts.," suggesting either that he equated the new species with *P. mollis* based on the material he had previously observed, or perhaps he had communication with botanists in the area and assumed the material to be conspecific with *P. mollis* based on descriptions, possibly of the

striking vestiture. The historical paucity of herbarium specimens of *P. solivagus* clearly hindered an understanding of diversity of *Phlox* in the region.

Phlox solivagus is readily differentiated from other caespitose *Phlox* of the area by its leaves with copious, lanate vestiture and distinctly thickened margins, along with glandular vestiture limited to the inflorescence (calyx, pedicels, and bracts subtending flowers). It co-occurs at Griffin Peak with *P. multiflora*, which can be differentiated by its glabrescent leaves and inflorescence herbage that is glabrescent or with sparse, eglandular trichomes (among other characteristics). *Phlox solivagus* co-occurs at Cape Horn Ridge with *P. hoodii*, which has leaves with sparse, eglandular vestiture, and inflorescence herbage with sparse, long, eglandular vestiture (becoming lanate inside calyx lobes). *Phlox douglasii* occurs near the Griffin Peak population and, like *P. solivagus*, has gland-tipped trichomes throughout the inflorescence; throughout the plant, however, its leaves bear gland-tipped trichomes — the vestiture is not lanate. In the vicinity of Griffin Peak, both *P. multiflora* and *P. douglasii* begin to flower when *P. solivagus* is past its peak flowering time. At Cape Horn Ridge, *P. hoodii* flowers at the same time or somewhat before *P. solivagus*, but its flowers are much smaller and white to blue lavender. While flower color is not normally a good taxonomic character in *Phlox*, it may be somewhat useful in the Blue Mountains: all populations of *P. solivagus* observed consistently exhibit lavender pink corollas, while co-occurring *P. multiflora*, like *P. hoodii*, is white to pale blue lavender (Figs. 3, 4). Both *P. longifolia* and *P. viscida* occur in the Blue Mountains (the former being common at lower elevations and the latter occurring on relatively mesic slopes in the arid eastern portion of the area up into the mountains in canyons), and each of these has a more upright growth habit, typically with many-flowered inflorescences. Finally, *P. speciosa* occurs in the broader region surrounding the northern Blue Mountains; it also exhibits a tall, open growth habit and is most easily differentiated from other upright *Phlox* in the area by its notched petals and very short style (positioned deep in the corolla tube, well below all of the anthers). A key to *Phlox* species occurring in the northern Blue Mountains is provided below.

Key to *Phlox* of the northern Blue Mountains

1. Plants tall, with an open, upright habit (usually much more than 1.5 dm tall), with several to many erect to decumbent-ascending stems arising from an openly branched woody base; flowering stems elongating, rising to well above the sterile stems (when the latter are present); flowers in cymose inflorescences with 3–many flowers; plants occurring in grasslands and canyons, common at lower elevations in the northern Blue Mountains or on mesic canyon slopes within arid areas at higher elevation.

   2. Stems typically with many short axillary shoots; the longest leaves 50–80 mm; inflorescence herbage densely glandular pubescent; the membranes between calyx lobes sunken to flat (or slightly plicate but never protruding toward the base) ..... **Phlox viscida**
   2. Stems typically without axillary shoots; the longest leaves 25–45 mm; inflorescence herbage glabrous to eglandular or glandular pubescent; the membrane between calyx lobes distinctly plicate and bulging (saccate) toward the base ..... **Phlox longifolia**

1. Plants low, compact to loose spreading tufts or mounds (mostly less than 1 dm tall), with many stems spreading from a closely branching, woody base; flowering stems positioned among leafy stems (when the latter are present); flowers solitary and terminal or in cymose inflorescences with 2–3 flowers; plants occurring on open flats and slopes, chiefly at higher elevations in the northern Blue Mountains.

   3. Calyx with gland-tipped trichomes; corollas shades of pink (within the area; *P. douglasii* sometimes white elsewhere).

4. Leaves gray-green, dull, densely lanate on both surfaces, the margins thickened and involute towards the apex, the longest 8–20 mm in length; calyx with gland-tipped hairs externally, but with woolly, eglandular hairs (lanate) internally toward the lobe tips; corollas larger, the lobes mostly 8–10 mm in length ..... **Phlox solivagus**
4. Leaves dark green, lustrous, glabrescent to sparsely glandular pilose, the margins not thickened, the longest 7–12 mm in length; calyx with gland-tipped hairs externally, the lobes glabrescent or with sparse, gland-tipped hairs internally; corollas smaller, the lobes mostly 5–8 mm in length ..... **Phlox douglasii**

3. Calyx glabrous, or with eglandular trichomes; corollas white to pale blue lavender (within the area).

5. Stems with the distal internodes mostly concealed by the leaves, usually with arachnoid woolly pubescence; longest leaves 6–12 mm in length; inflorescence herbage densely to sparsely lanate, especially near the sepal bases; the membranes between calyx lobes flat to slightly keeled ..... **Phlox hoodii**
5. Stems with the distal internodes readily visible, glabrous or with short patent hairs; longest leaves 11–35 mm in length; inflorescence herbage glabrous (within the area); the membranes between the calyx lobes flat to sunken ..... **Phlox multiflora**

It is remarkable that such a distinctive and showy species occurring on public lands could be, until very recently, largely unnoticed and so rarely collected by botanists. While parts of the Blue Mountains of Oregon and southeast Washington are rather remote and difficult to access, two of the presently known populations of *Phlox solivagus* are readily accessed via the local Forest Service road system (the population at Griffin Peak is at the site of a former fire observation station!). However, the new species flowers very early within the area — in its exposed habitat, *P. solivagus* flowers in mid-May and early June, when easy routes to the Griffin and Squaw Peak sites in particular are typically restricted by snow. Botanists visiting the area later in the year are unlikely to pay much notice to material with senesced infructescences — thus, a lack of collections. Even so, the species is easily identifiable any time of the year when snow is absent, and agency botanists conducting surveys would likely have noted the distinct character of the plant in the past had it been encountered.

Authors have noted both the ongoing discovery of new plant taxa in North America (e.g., Ertter 2000, Hartman & Nelson 1998) and the importance of continued collecting efforts (e.g., Prather et al. 2005a, 2005b). Indeed, undescribed vascular plant taxa in the Blue Mountains region are being discovered on a regular basis (e.g., Darrach & Wagner 2011, Darrach & Hinchliff 2014, MED pers. comm.). Our study highlights the importance of focused botanical collecting with regard to "holes" in specimen holdings and, in this case, a possible "hole" with respect to phenology in an area (rather than a simple case of limited collecting in a geographical area). We hope that the present study spurs not only detailed research on *P. solivagus* but increased botanical interest in the clearly undercollected Blue Mountains region in general.

ACKNOWLEDGEMENTS

The illustrations were graciously provided by Terri Knoke. We thank USDA Forest Service Region 6 personnel for assistance with permitting and are particularly grateful to Alan Ager, Tom Brumbelow, Joan Frazee, Terri Knoke, and Mark Skinner for logistical support. Thanks to Mercedes Santiago and Kate Waselkov for reading the manuscript; and much appreciation to Guy Nesom for editorial work and review and to Bob Patterson for review. We acknowledge support from NSF DEB-1258167 and the Kansas Agricultural Experiment Station (contribution no. 15-351-J).

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA
Part 13. EUDICOTS: EUPHORBIACEAE – SPURGE FAMILY

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ABSTRACT

A floristic and natural history account is provided for the spurge family as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the Sonoran Desert of southwestern Arizona. This contribution includes 31 species in 8 genera, all of which are native to the region except *Euphorbia prostrata* and perhaps *Euphorbia spathulata*. At least 9 species are represented in fossil record. *Euphorbia*, with 18 species, is the most diverse genus in the flora of southwest Arizona. *Euphorbia spathulata* is the only obligate cool-season ephemeral among the spurge family in the flora area and is not known elsewhere in the core area of the Sonoran Desert, and *Jatropha cinerea* is not known elsewhere in the USA.

This publication, encompassing the Euphorbiaceae, is our 13th contribution to the vascular plant flora in southwestern Arizona. The flora area covers 5141 km^2 (1985 mi^2) of contiguous protected areas in the heart of the Sonoran Desert (Fig. 1). This contribution also is available open access on Richard Felger's webpage on the website of the University of Arizona Herbarium (http://ag.arizona.edu/herbarium/people/rfelger).

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. Fossil specimens are indicated with a dagger symbol (†). The one non-native species of Euphorbiaceae is marked with an asterisk (*). In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish, and the Hia-Ced O'odham dialect, respectively (see Felger 2007 and Felger et al. 1992 for usage of Hia-Ced O'odham plant names). Spanish-language names are italicized. The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that many quantitative values in the descriptions are, to varying degrees, seldom exact.

All photos and scans are by Sue Rutman unless otherwise stated and botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986), Matthew B. Johnson, and Marlo Buchmann. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2014). We have seen specimens or images of all specimens cited. When no collection number is provided, the specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Additional explanation of the format for this flora series is provided in Part 3 (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

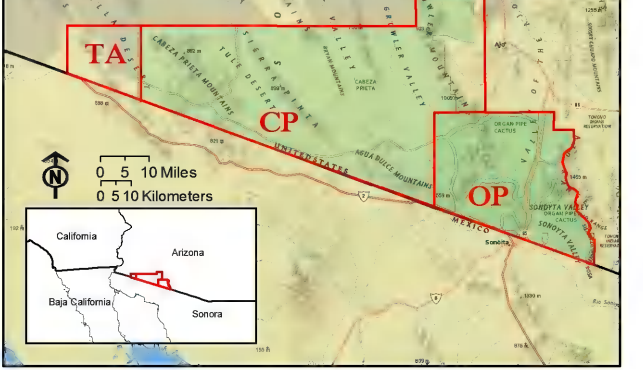

Figure 1. Flora area in southwestern Arizona. TA = Tinajas Altas Region; CP = Cabeza Prieta National Wildlife Refuge; OP = Organ Pipe Cactus National Monument. Green shading indicates approximate boundaries of federally designated wilderness.

EUPHORBIACEAE – Spurge Family

This large and diverse, mostly tropical and subtropical family is well represented in the Sonoran Desert. Plants of diverse habit, often with milky or watery sap. Leaves alternate, opposite or whorled (in some *Euphorbia*), simple (those in the flora area), mostly with stipules, although the stipules often small or quickly deciduous, or sometimes lacking. Inflorescences basically cymose but sometimes greatly reduced (as a cyathium in *Euphorbia*). Flowers unisexual; different flower parts often reduced, sometimes greatly so; perianth often inconspicuous, the tepals separate or united

below, or the petals or entire perianth absent. Ovary superior, mostly 3-chambered; styles usually 3, simple or branched. Fruits of capsules (those in the flora area), the segments (mericarps) usually 3 (or 1 or 2 by abortion). Seeds with or without a knob-like basal appendage (caruncle). Worldwide, 218 genera, 6745 species.

The spurge family in the flora area includes 31 species in 8 genera (Table 1). *Euphorbia*, with 18 species, is the most diverse genus in this flora. *Euphorbia prostrata* is the only species in the spurge family known to be non-native in the region, although *E. spathulata* may have been introduced in historic times. *Euphorbia spathulata* stands out as the only strictly cool-season ephemeral member of the family in the flora area and is not known elsewhere across most of the Sonoran Desert. *Jatropha cinerea* is not known elsewhere in the USA. At least 9 present-day species are also represented in the fossil record, documented from plant fragments recovered from packrat middens (see Felger et al. 2013a). The majority of species (83%) occur in Organ Pipe and only 26% are found in the hyperarid Tinajas Altas Region. Ten species are ephemerals and 5 are facultative annuals or perennials, together representing 48% of the total spurge flora. Seven species are shrubs: *Acalypha californica*, *Argythamnia brandegeei*, *Croton sonorae*, *Jatropha* with 3 species, and *Pleradenophora bilocularis*. The remaining perennials are herbaceous or subshrubs, and although they may flower in their first season, they are most often encountered as perennials. We have seen moderate to severe freeze damage on 8 perennials in the flora area: *Argythamnia brandegeei*, *A. lanceolata, Croton sonorae, C. wigginsii, Jatropha cinerea, J. cuneata, Stillingia linearifolia*, and *Pleradenophora bilocularis* (see Turner et al. 1995).

Table 1. Local distributions and growth forms of Euphorbiaceae in southwestern Arizona. † = Taxa also represented by fossil specimen(s); * = non-native species. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = summer/warm-season ephemerals; WI = winter-spring/cool-season ephemerals; NS = non-seasonal ephemerals; AP = facultative annuals or perennials; PR = perennials.

Taxon	Region			Growth Form				
				Ephemerals			Perennials	
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter	Non-seasonal	Facultative annual or perennial	Perennial
Acalypha californica	OP	CP						PR
Argythamnia adenophora	OP							PR
Argythamnia brandegeei		CP						PR
†*Argythamnia lanceolata*	OP	CP	TA					PR
†*Argythamnia serrata*	OP	CP	TA				AP	
†*Argythamnia* sp.			(TA)					
Croton sonorae	OP	CP						PR
Croton wigginsii		CP						PR
Euphorbia abramsiana	OP	CP	TA	SU				
Euphorbia albomarginata	OP	CP						PR
Euphorbia arizonica	OP							PR
Euphorbia capitellata	OP							PR
Euphorbia eriantha	OP	CP	TA			NS		
Euphorbia exstipulata	OP			SU				

Euphorbia florida	OP	CP		SU				
Euphorbia heterophylla	OP			SU				
†*Euphorbia hyssopifolia*	OP	CP		SU				
†*Euphorbia melanadenia*	OP							PR
Euphorbia micromera	OP	CP					AP	
Euphorbia pediculifera	OP	CP					AP	
Euphorbia platysperma			TA					PR
Euphorbia polycarpa	OP	CP	TA				AP	
**Euphorbia prostrata*	OP			SU				
Euphorbia setiloba	OP	CP	TA			NS		
Euphorbia spathulata		CP			WI			
Euphorbia trachysperma		CP		SU				
†*Euphorbia* sp./spp. (Hypericifoliae)	(OP)		(TA)					
†*Jatropha cardiophylla*	OP							PR
Jatropha cinerea	OP							PR
†*Jatropha cuneata*	OP	CP	TA					PR
†*Pleradenophora bilocularis*	OP	CP						PR
Stillingia linearifolia	OP	CP					AP	
†*Tragia* sp.	OP							PR
Totals	**26**	**20**	**8**	**6**	**1**	**2**	**5**	**16**
Percent of family in flora area	**84%**	**65%**	**26%**					
Percent of growth form in family				**19%**	**3%**	**6%**	**16%**	**55%**

1. Shrubs, or semi-shrubs, woody or not, often reaching 1 m or more in height.

2. Sap thick and conspicuously milky; leaves often with a pair of glands at the base of the blade ..... **Pleradenophora**

2. Sap watery or blood-like, or essentially absent, never milky.

3. Leaf margins with small, regularly spaced teeth (crenulate-toothed); styles multiple-branched with conspicuous red (rarely white), thread-like segments ..... **Acalypha**

3. Leaf margins entire, or with a few broad lobes, or minute teeth near the tip; styles entire or 2-branched (bifid).

4. Herbage, flowers, and fruits glabrous or with short, simple hairs; sap copious, watery or blood-like; leaves deltate, cuneate, or kidney-shaped to orbicular ..... **Jatropha**

4. Herbage, flowers, and fruits with 2-armed, stellate, or simple hairs; sap not copious, not as above; leaves lanceolate to elliptic.

5. Stems tough, not brittle, not semi-succulent; herbage and fruits with stellate hairs ..... **Croton**

5. Stems brittle and semi-succulent; young herbage and ovaries/fruits with 2-armed and coarse simple hairs, the mature herbage glabrate or sparsely pubescent ..... **Argythamnia brandegeei**

1. Annuals or perennial herbs, usually not woody, mostly less than 1 m tall.

6. Leaves alternate, opposite, or whorled; sap conspicuously milky; flowers in cyathia (small, head-like, compact inflorescences simulating a "normal" bisexual flower); sepals and petals none (white or pink petal-like appendages often extend from oval or round glands) ..... **Euphorbia**
6. Leaves alternate; sap not milky (or if milky then weakly so and rather watery in *Stillingia*) or essentially absent; flowers not in cyathia; sepals and petals variously present or absent.

7. Plants glabrous ..... **Stillingia**
7. Plants pubescent.

8. Stems slender and usually twining, the plants with stinging hairs ..... **Tragia**
8. Stems not twining, the hairs not stinging.

9. Plants with stellate hairs or stellate-lepidote scales ..... **Croton**
9. Plants with simple or 2-armed hairs (sometimes glabrate).

10. Plants usually glandular-viscid and sticky, with simple hairs (glandular and non-glandular); corollas (petals) none; stigmas red (rarely white) and conspicuous, each divided into multiple thread-like segments ..... **Acalypha**
10. Plants not glandular-viscid, the hairs 2-armed or simple, or plants sometimes largely glabrate; petals present, or sometimes essentially absent on male flowers; stigmas bifid (each stigma 2-branched), not red and not especially conspicuous ..... **Argythamnia**

Acalypha

Annuals to small trees; worldwide, mostly tropics and warm temperate region; 450 species (Levin, in press).

Acalypha californica Bentham

[*A. pringlei* S. Watson, see Levin 1995 and Levin & Gillespie in press]

California copperleaf; *hierba del cáncer*. Figure 2.

Shrubs mostly less than 1 m tall, sometimes to 1.5 m tall, with slender stems; sap essentially absent. Herbage viscid-sticky, with glandular and non-glandular simple hairs; young herbage densely pubescent; herbage becoming brownish during drought and plants eventually leafless in severe drought. Leaves alternate, petioled; leaf blades 1.5–5.5 cm long, ovate to cordate, the margins crenulate-toothed (the blades larger, thinner, greener, and less glandular when growing during warm weather and high soil moisture). Male and female flowers on the same plant, the flowers in axillary spikes. Flowers subtended by bracts; bracts of female flowers broad, toothed, markedly glandular, and enlarging with age. Calyces small; corollas none. Styles 3, the styles and stigmas 5–8 (9) mm long, red (rarely white), conspicuous, and divided into many thread-like segments. Fruits 3-seeded capsules. Seeds 2 mm long, obovoid, with a minute caruncle. Plants frost-sensitive, the aboveground herbage sometimes freeze-killed, and plants usually re-sprouting in spring. Flowering at various seasons, most luxuriantly with summer-fall rains.

Widely scattered: washes, canyons, and rocky slopes, the distribution largely limited by winter freezing. Widely scattered in Organ Pipe and probably in most or all mountain areas. Cabeza Prieta, especially in the eastern part and elsewhere in canyons in the larger mountains. Felger et al. (2012) list a specimen from Tinajas Altas (*Goodding 5 Dec 1935*), but we have not been able to locate the specimen and have not found any *Acalypha* specimens from Yuma County. The conspicuous multi-branched styles are unique among the spurge family in the flora area.

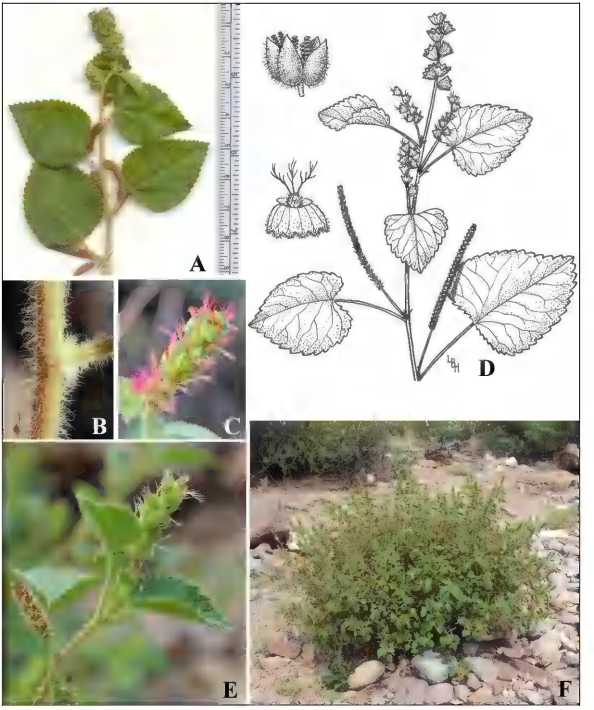

Figure 2. *Acalypha californica*. Alamo Canyon: (A) 10 Sep 2008; (B) 11 Mar 2014. (C, E & F) Estes Canyon near trailhead, 14 Aug 2013. (D) By Lucretia Breazeale Hamilton.

Northwestern Sinaloa to southwestern Arizona, and Baja California Sur to southern California.

OP: Canyon Diablo, 21 Mar 1935, *Peebles 10819*. Alamo Canyon, 12 Dec 1939, *Harbison 26237*. Bates Well, S slope, washes, scattered, small shrub, 12 Sep 1952, *Blakely B-1594* (DES, UCR). Estes Canyon, *Hesselberg 16 Oct 1966*. Twin Peaks, above residence area, 9 Sep 1984, *Van Devender 84-450*. Aguajita, 6 Apr 1988, *Felger 88-275*. Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-545*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-282*.

CP: Charlie Bell Pass road, 27 Sep 1992, *Harlan & Steinmann 347*. Little Tule Well, 18 Aug 1992, *Felger 92-649*.

Argythamnia – Silverbush

Annual or perennial herbs, subshrubs, or shrubs (elsewhere rarely small trees), with 2-armed hairs at least on ovaries and capsules and also with simple (unbranched) hairs (rarely glabrate or glabrous). The 2-armed (malpighiaceous) hairs are unique among the Euphorbiaceae in the Sonoran Desert; these hairs are often glassy, with the opposite arms lying close to the surface (appressed). Leaves alternate. Male and female flowers on the same plant (or perhaps sometimes on separate plants in *A. lanceolata*). Flowers axillary, usually in short racemes, the lower flowers in bisexual inflorescences female, the upper ones male. Female flowers conspicuously larger than the male flowers; sepals 5, petals 5. Male flowers with 5 glands opposite the sepals, petals present or absent, the stamens usually in 2 whorls of 5 each, the filaments united into a column (unique among members of the Euphorbiaceae in the flora area). Fruit a capsule splitting into three 1-seeded segments. Seeds without a caruncle (those in the flora area).

Argythamnia is a genus of 88 species in the Americas, mostly tropics, subtropics, and warm temperate regions with three subgenera including *Ditaxis* (Ramírez-Amezcua & Steinmann 2013). The Sonoran Desert taxa are in the subgenus *Ditaxis*, which includes about 50 species in the Americas, mostly in the tropics and subtropics, especially in arid and semi-arid regions. Subgenus *Ditaxis* has often been treated at the generic level.

1. Leaf margins with gland-tipped teeth……. **Argythamnia adenophora**
1. Leaf margins entire or the teeth not gland-tipped.

2. Plants spindly shrubs often more than 1 m tall; new growth and ovaries hairy, the rest of plant glabrous or sparsely hairy ……..…….. **Argythamnia brandegeei**
2. Plants less than 1 m tall, densely and coarsely hairy throughout (or plants growing in the shade and with ample soil may be only sparsely pubescent).

3. Herbaceous perennials to subshrubs; stems mostly erect and straight; male flowers with petals ……..…….. **Argythamnia lanceolata**
3. Plants herbaceous; stems mostly ascending to spreading, or sometimes the main axis at first erect but the branches spreading and seldom straight; male flowers without petals. ……**Argythamnia serrata**

Argythamnia adenophora A. Gray
[*Ditaxis adenophora* (A. Gray) Pax & K. Hoffmann]
Figure 3.

Herbaceous perennials, sometimes reproducing in the first season. Plants with simple hairs, except ovaries and capsules with 2-armed hairs. Leaf margins, stipules, and female sepals bear numerous, conspicuous, and relatively large tack-shaped glands; leaf blades elliptic to obovate, mostly 1–5 cm long. Male and female flowers occur on the same plant.

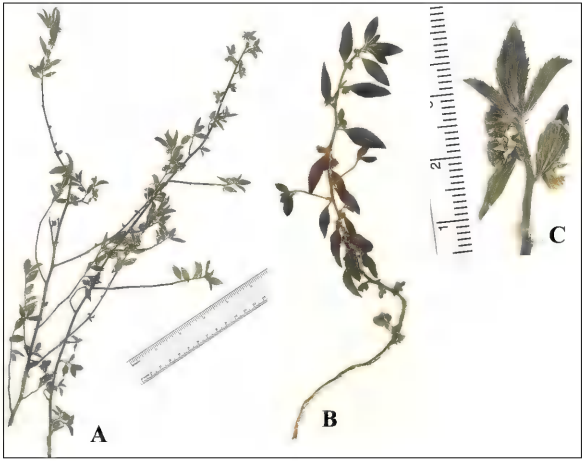

Figure 3. *Argythamnia adenophora*. (A & C) Base of Sierra Estrella, 6 mi NNE of Mobile, Maricopa Co., 29 Mar 2000, *Landrum 9687* (ASU). (B) N of Parker, Holiday Harbor near Castle Rock, Yuma Co., 9 Mar 1974, *Russell 74-14-HHS* (ASU).

Known from two records in central part of Organ Pipe.

Southwestern Arizona and western Sonora. *Argythamnia adenophora* is replaced by *A. claryana* Jepson in southeastern California and in western Arizona northward from the range of *A. adenophora*. *Argythamnia claryana* differs most notably in having herbage with numerous 2-armed hairs and generally more slender glands (Ramírez-Amezcua & Steinmann 2013; Steinmann & Felger 1997). *Argythamnia claryana* is sometimes treated as a synonym of *A. adenophora*.

OP: Twin Peaks, near Visitor Center, 1800–1900 ft, S-facing volcanic slope, *Van Devender 19 Feb 1984*. Puerto Blanco Mts, 2 mi E of Visitor Center on Ajo Loop Road, SW-facing rhyolitic rock shelter, 1800 ft, 15 Apr 1985, *Van Devender 85-107*.

Argythamnia brandegeei Millspaugh var. **intonsa** (I.M. Johnston) J.W. Ingram
[*Ditaxis brandegeei* (Millspaugh) Rose & Standley var. *intonsa* I.M. Johnston]
Sonoran silverbush. Figure 4.

Slender, and usually sparsely-branched perennials often 1–2.5 m tall, sometimes with a woody trunk to 3 cm in diameter. Stems 4–8 mm diameter in the first season, herbaceous and pithy, brittle, semi-succulent, with long internodes. Young stems glabrate or sparsely pubescent, the leaves mostly sparsely pubescent and becoming glabrate with age; capsules sparsely to densely covered with

coarse, 2-armed hairs; herbage often of an unusual blue-green color usually accentuated when dry, or sometimes reddish. Foliage sparse; leaves (3) 5–9.5 × (0.7) 1–2.8 cm, quickly drought-deciduous, usually present only on upper nodes, petioled, the blades lanceolate to sometimes elliptic, the margins with small gland-tipped teeth. Stipules glandular, horn-like, 0.4–0.5 mm long, quickly deciduous or perhaps sometimes absent. Male and female flowers occur on the same plant. Flowers yellow-green, the male flowers with laciniate-fringed petals. Seeds 3.5–4 mm long, ovoid, and brown. Flowering at various seasons.

Figure 4. *Argythamnia brandegeei* var. *intonsa*. Granite hill about 0.1 mile S of Mex Hwy 2, 123 km W of Sonoyta, E side of Sierra Nina (= Sierra del Águila), Sonora, 7 Mar 2015.

Thinly distributed in the Tule and Cabeza Prieta mountains and common in the Gila Mountains north of the Tinajas Altas Region, where it approaches the Tinajas Altas Region at the Fortuna Mine site. This unique and rather strange plant generally grows from crevices of canyon walls and rock faces in hot, arid habitats. Often heavily browsed by bighorn sheep (Simmons 1966) and sometimes damaged by freezing weather (e.g., *Rutman 17 Feb 2002*, below).

Two varieties are recognized (Ramírez-Amezcua & Steinmann 2013), but the differences seem rather insignificant. Variety *intonsa* occurs in southwestern Arizona, northwestern Sonora, and both Baja California states. Variety *brandegeei* also occurs in both Baja California states and is characterized as being glabrous. The Arizona and Sonora plants match var. *intonsa*, distinguished from var. *brandegeei* "only in possessing a few scattered, very coarse, appressed, malpighian hairs on the leaves and young stems, and in the densely setose-hispid capsules" (Wiggins 1964: 786). The term *intonsa*, "unshaven," refers to the hairy ovaries and capsules. However, an occasional specimen from Sonora (e.g., *Turner 59-308*) is sparsely hairy or the ovaries glabrous or glabrate.

CP: Tule Tanks, 4 Dec 1935, *Goodding 4358*. Cabeza Prieta Tanks, 19 Mar 1960, *Monson 2*. Tule Mts, 1200 ft, about 2 dozen browsed plants with new leaves and branches, 10 Apr 1994, *Harlan 440*. Tule Mts, UTM 12 244001, 3552930, 1600 ft, steep granite boulder & bedrock S-facing slope, fewer than ten plants seen, some damaged by recent [freezing] temperatures, *Rutman 17 Feb 2002*.

Yuma Co.: The specimen label: "Stony wash in the desert western foot of Fortuna Mtns., snaky shrub 2–3 m. high, March 27, 1935, *Aven Nelson, Ruth A. Nelson No. 1303*" (RM).

†**Argythamnia lanceolata** (Bentham) Müller Argoviensis
[*Ditaxis lanceolata* (Bentham) Pax & K. Hoffmann]
Narrow-leaf silverbush. Figure 5.

Sparsely to densely branched and silvery-pubescent perennial herbs to subshrubs, and also flowering in the first season; often forming clumps 30–70 cm tall. Stems slender and brittle, the herbage silvery hairy during dry seasons, the new growth greener, more sparsely pubescent, and the leaves larger and thinner following hot, wet weather. Leaves 5–42 × 2–9 mm, linear lanceolate to broadly lanceolate; stipules bristle-like, ± 1 mm long. Male and female flowers occur on the same plant or perhaps on different plants. Flowers green and white, inconspicuous; warmer months. Seeds 2.3–2.5 mm long, reticulate with shallow craters having radiating lines, the seed base flat (the seed will sit on end, being "chunkier" than those of *D. serrata*).

Common and widespread across the flora area; washes, canyons, bajadas, and rocky slopes to summit elevations. Often heavily browsed, including by bighorn sheep (Simmons 1966), chuckwallas, and rabbits; these browsed plants sometimes reduced to clusters of stem stubs. Monson (1955: 3) reported that "bighorn sheep go to extreme lengths to gather the scattered sprouts and sparse leaves." The new growth is sometimes freeze-damaged. It has grown in the flora area for more than eight millennia.

Nearly throughout the Sonoran Desert in Arizona, California, both Baja California states, and Sonora.

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939*. Above Dripping Springs, Puerto Blanco Mts, monoecious but mostly staminate, 16 Apr 1952, *Parker 7946*. Quitobaquito, 14 Sep 1988, *Felger 88-458*. 0.5 mi S of mouth of Alamo Canyon, *Warren 18 Apr 1975*. Alamo Canyon, *Rutman 5 Sep 1999* (ORPI). 2.3 mi N of junction Puerto Blanco Drive & Pozo Nuevo Rd, *Rutman 30 Aug 2001* (ORPI). †Puerto Blanco Mts, on ridge, leaves, capsules, seeds, 980 to 3440 ybp (8 samples).

CP: Tule Tank, 15 Apr 1941, *Benson 10801*. Near Cabeza Prieta Tanks, *Simmons 25 Oct 1962* (CAB). Charlie Bell Pass, 3 Apr 1992, *Whipple 3935*. Base of Scarface Mtn, 1650 ft, *Autenreith 20 March 1992* (DES). Observations: 0.5 mi S of Sunday Pass, 2600–2700 ft, 15 Nov 2003, *James W. Cain III;* Agua Dulce Pass, Buck Mt Tank, North Pinta Tank, 13 & 14 Jun 1992, *Felger*.

TA: Tinajas Altas Mts: 5 Mar 1927, *Harrison 3611*; 1530 ft, 26 Oct 2004, *Felger 04-80* (ARIZ, ASU, CAS, TEX). Borrego Canyon, 16 Jun 1992, *Felger* (observation). 1 mi N of Tinajas Altas Pass road, 1250 ft,. 19 Mar 1983, dioecious, *Yeatts 433* (DBG: KHD). Tinajas Altas Mts, †Butler Mts, leaves, fruits, 8160 ybp.

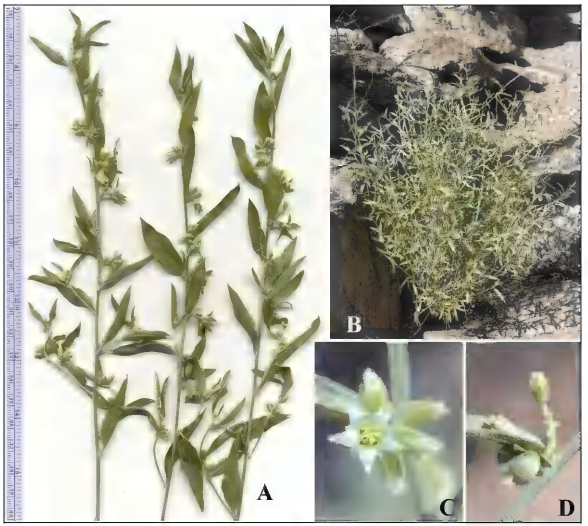

Figure 5. *Argythamnia lanceolata*. (A) Alamo Canyon, 15 Sep 2013. (B) Canyon, N side of Little Ajo Mts, 20 Oct 2008. Estes Canyon, 27 Feb 2014: (C) male flower, (D) female flower and male flower bud.

†**Argythamnia serrata** (Torrey) Müller Argoviensis
[*Aphora serrata* Torrey. *Ditaxis serrata* (Torrey) A. Heller. *Argythamnia neomexicana* Müller Argoviensis. *Ditaxis neomexicana* (Müller Argoviensis) A. Heller]
New Mexico silverbush; *cualilla*. Figure 6.

Non-seasonal ephemerals or small, short-lived herbaceous perennials; often much branched, and with 2-armed hairs. Leaves mostly 1.2–3.5 cm long, elliptic or oblanceolate, the tip acute to obtuse, or truncate, the margins entire or with a few small teeth; leaves longer (to 5 cm), broader, greener, not as thick, and less hairy when produced during warm, wet conditions than in drier or drought conditions; stipules minute, soon deciduous. Flowers green and white, small and inconspicuous. Male and female flowers occur on the same plant. Male flowers: sepals green, the petals longer than the sepals, obovate, white with red-purple veins, the glands 0.5 mm wide, transparent-membranous, with age becoming yellow-brown and thickened, the staminal column 1.5 mm long, the stamens in 2 whorls near the column apex. Female flowers: sepals 3.2–4 mm long, the petals 1.5–3 mm long. Seeds 2 × 1.5–1.6 mm, ovoid with a pointed tip, brown with low hairs forming fine radiating lines from minute crater-like pits or a reticulate pattern (the radiating lines often not formed on immature seeds).

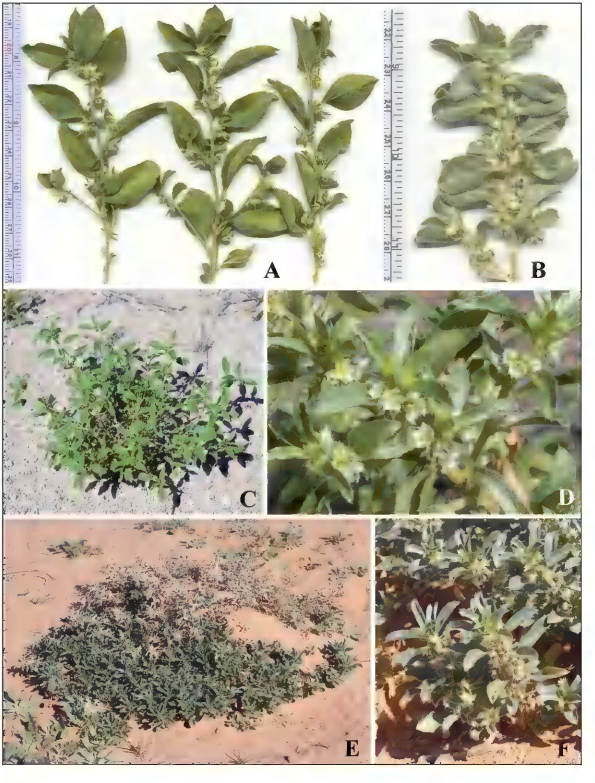

Figure 6. *Argythamnia serrata*. (A) Why, 15 Sep 2013. (B) Gran Desierto, Sonora, 5 Mar 2014. (C) International boundary W of Quitobaquito, 5 Sep 2013. (D) Dos Lomitas, 22 Feb 2005. (E) Pinta Sands, 11 Feb 2013. (F) Gran Desierto near Mex Hwy 2, 5 Mar 2014.

Common and widespread throughout most of the flora area in many habitats, including washes, plains, bajadas, and rocky slopes, and especially on loamy flats. As with *A. lanceolata*, *A. serrata* has grown in the flora area for at least eight millennia.

Southwestern United States and Mexico to Guatemala.

Ramírez-Amezcua and Steinmann (2013) treated *A. neomexicana* as a synonym of *A. serrata*, which has priority as the basionym *Aphora serrata*. *Argythamnia serrata* sensu stricto is a sand-adapted plant found on dunes and sand flats in the southern part of Cabeza Prieta, and distinguished from *A. neomexicana* sensu stricto by its robust habit of growth, stouter and deeper taproot, generally larger hairs, lighter-colored foliage, and usually broader and blunter (commonly truncate) leaves. Their local distributions are narrowly separated by differences in habitat.

OP: Dripping Springs, Puerto Blanco Mts, 15 Apr 1952, *Parker 7915*. Quitobaquito, 13 Sep 1986, *Felger 86-291*. 2.3 mi N of junction Puerto Blanco Drive & Pozo Nuevo Rd, *Rutman 30 Aug 2001* (ORPI).
CP: Pinacate Plateau, *Goodding 29 Nov 1938*. N side of Tule Mts, 2 Feb 1992, *Felger 92-61*. Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-661*. Pinta Sands, 15 Sep 1992, *Felger 92-783*.
TA: Camino del Diablo, E of Raven Butte, 29 Oct 2001, *Felger 01-589*. Mexico border at mouth of Frontera Canyon, 18 Mar 1998, *Felger,* observation. †Butler Mts, leaves, fruits, seeds, 3820 & 8570 ybp.

†**Argythamnia** sp.
TA: †Tinajas Altas, seeds, 5860 to 8255 ybp (3 samples).

Croton

The two species in the flora area are perennials (the genus elsewhere includes annuals to perennials, shrubs, and trees) with stellate hairs or stellate-lepidote scales. Sap clear (those in the flora area). Leaves alternate, margins entire (those in the flora area), becoming orange as they age and fall. Fruit a 3-seeded capsule. Seeds with a caruncle.

Warm regions, especially in the tropics, with centers of diversity in Mexico and Brazil; more than 1200 species worldwide, including over 700 in the New World, making it one of the "giant genera" of angiosperms (Frodin 2004; Govaerts et al. 2000; van Ee et al. 2011).

1. Branches firm and woody; herbage with stellate pubescence; male and female flowers on the same plant; mostly in rocky soils or gravelly washes..... **Croton sonorae**
1. Branches mostly herbaceous and flexible; herbage with stellate-lepidote scales; male and female flowers on separate plants; dunes and sand flats..... **Croton wigginsii**

†**Croton sonorae** Torrey
Sonoran croton; *rama blanca*. Figure 7.

Shrubs mostly 0.4–1.5 m tall, the wood hard and the bark dark-gray to blackish. Leaves 2.5–4 cm long, drought-deciduous, variable in size depending on soil moisture, petioled; leaf blades lanceolate to ovate, densely stellate-pubescent when young, becoming sparsely haired or glabrate with age, especially the upper surfaces, and often orange or tinged with orange; margins entire or slightly and irregularly sinuate; stipules not evident (those in the flora area). Male and female flowers on the same plant, both with petals; female flowers green and inconspicuous, the male flowers white; flowering at various seasons, especially during the summer rainy season. Seeds 4.7–5.5 mm long, broadly ovoid, shiny, and mottled.

Mostly in canyons and rocky slopes, especially west and south-facing exposures. Widely scattered in Organ Pipe, at least in the Ajo, Puerto Blanco, and Santa Rosa mountains, and granitic mountains on the east side of Cabeza Prieta. Many *C. sonorae* plants in the flora area are relatively

small and stunted, probably as a result of the arid conditions and repeated freeze damage. It has an 8600-year history in Puerto Blanco and Ajo mountains.

Southern Arizona to Sinaloa and Baja California Sur; and disjunct in Guerrero, Puebla, and Oaxaca.

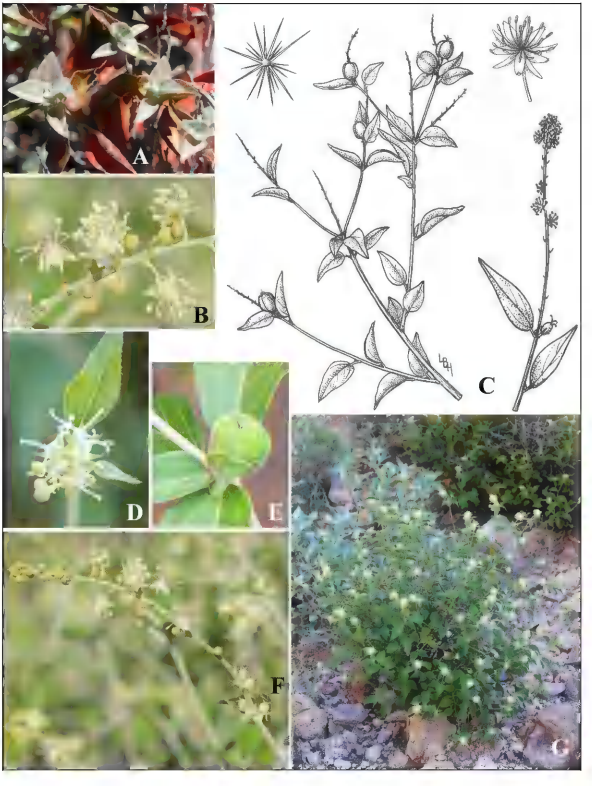

Figure 7. *Croton sonorae*. (A) S-facing slope, Bull Pasture Trail, 6 Mar 2005. (B, D–G) Foothills of Pinkley Peak, 8 Aug 2013. (C) By Lucretia Breazeale Hamilton.

Croton sonorae is a member of section *Adenophylli*, the largest of the New World sections of *Croton* with approximately 223 species (Van Ee et al. 2011). Van Ee and Berry (in press) report "stipules subulate, to 1 mm." However, Felger looked at specimens at ARIZ and Walter Fertig looked at specimens at ASU and no stipules were detected, and Wiggins (1964: 78) says "stipules obsolete."

OP: Bull Pasture Trail, 11 May 1978, *Bowers 944*. Walls Well Rd, *Van Devender 30 Aug 1978*. Growler Mts, W of Growler Pass, 7 Mar 2003, *Rutman 2003-249* (ORPI). Foothills of the Puerto Blanco Mts, N of Pinkley Peak, 2020 ft, shrub 1–1.5 m tall, *Rutman 8 Aug 2013*. †Alamo Canyon, fruits, seeds, 1150 to 8590 ybp (3 samples). †Puerto Blanco Mts, on ridge, leaves, seeds, 980 to 3400 ybp (4 samples).

CP: Vicinity of Agua Dulce Spring, Agua Dulce Mts, 2080 ft, dwarfed shrub, ca. 40 cm tall, not common, 13 Jun 1992, *Felger 92-574*.

Croton wigginsii L.C. Wheeler
[*Croton arenicola* Rose & Standley, 1912. Not *Croton arenicola* Small, 1905]
Gran Desierto dune croton. Figure 8.

Herbaceous perennials to subshrubs to at least 1 m tall and scarcely woody at base; densely pubescent with silvery stellate-lepidote scales. Stems mostly erect, the branching pattern strict, the plants taller than wide. Leaves drought-deciduous, highly variable in size depending on soil moisture, often 1.5–6 cm long, petioled; the blades linear to narrowly lanceolate, the midrib prominent; minute, deciduous, cylindrical glands in the position of stipules. Male and female flowers on separate plants, the male flowers yellow, the female flowers green; both lacking petals. Seeds 4.4–7.8 mm long (based on specimens in adjacent Sonora). Flowering non-seasonally.

Cabeza Prieta on dunes and windblown sands in the vicinity of the Pinta Sands and Pinacate Lava Flow and westward in Yuma County near the international border, but not at Yuma (where one finds *C. californicus*). Also northwestern Sonora including the Gran Desierto (the type locality), desert areas in southeastern California including the Algodones Dunes, and northeastern Baja California. *Croton wigginsii* reaches 2.5 m tall in the dunes of the Gran Desierto in northwestern Sonora near the flora area (Felger 2000).

Croton wigginsii is a member of section *Drepadenium* with six species in North America and northern South America (Van Ee et al. 2011). It is an easily recognized allopatric member of the *C. californicus* complex, although the relationships, including geographic boundaries and interfaces of *C. californicus* and *C. wigginsii*, seem to be poorly resolved. Leaf size and shape and seed size are the most obvious distinctions, but leaf shape is highly variable and seeds are often not available. They usually can be distinguished as follows:

1. Stems divergent, the branches spreading, the plants often as wide as or wider than tall; leaf blades elliptic to narrowly oblong; seeds 4.0–4.5 mm long (populations in Arizona and Sonora) ..... **C. californicus**
1. Stems mostly erect, the plants generally taller than wide; leaf blades linear to linear-lanceolate or narrowly lanceolate; seeds 4.4–7.8 mm long..... **C. wigginsii**

The Cahuillas used *C. californicus* to treat earache and to relieve congestion from colds, but the plant is toxic and was used in small doses (Bean & Saubel 1972). However, the Cahuillas probably used *C. wigginsii* as well *C. californicus*.

CP: Pinta Sands: *Simmons 24 Nov 1962* (CAB); [Pinta Sands] 32°05'35"N 113°26'47"W, common on dunes with *Hilaria rigida, Stillingia* sp., *Aristida* sp., 9 Mar 1980, *Reichenbacher 446*. East Pinta Sands, 16 Jun 1992, *Felger 92-630A* (staminate), *Felger 92-630B* (pistillate). West Pinta Sands, only seen on moving dunes, bushy perennial ca. 60 cm tall, 11 Jan 2002, *Felger 02-19* (pistillate), *Felger 02-20* (staminate).

Figure 8. *Croton wigginsii*. Dunes 25 miles SW of Sonoyta on Mex Hwy 8: (A) 7 Sep 2014; (B) 27 Mar 2010; (C–E) 6 Feb 2014. (F) Pinta Sands, W of lava flow, 21 Jan 2015.

Euphorbia – Spurge

This is the largest genus in the flora area, with 18 species. Annuals or perennial herbs (those in the flora area) with latex (milky sap). Leaves alternate, opposite, or whorled, the blades symmetrical or not. Individual flowers borne in a cup-like structure, the cyathium, "present in every species of the genus but nowhere else in the plant kingdom" (euphorbiaceae.org), the whole structure superficially resembling a single "normal" flower (Figure 9). Each cyathium with fused bracts forming an involucre surrounding the flowers and bearing at its top 1–5 glands (those in the flora area); these glands with or without a petaloid (petal-like) appendage on the outside margin (width of

petaloid appendages measured perpendicular to the gland). Each cyathium with few to many minute male flowers and a single, much larger female flower (those in the flora area; elsewhere male and female flowers are sometimes on separate plants). Each male flower reduced to a single stamen fused to a short pedicel (stalk). The female flower reduced to a single pistil (ovary, styles, and stigmas) borne on a pedicel, extending beyond the edge of the cyathium and turning down and away from the male flowers (stamens). Styles 3, usually bifid (the 3 divided into 6 branches). Fruit a 3-seeded capsule. Seeds with or without a caruncle, and with or without mucilage when wet.

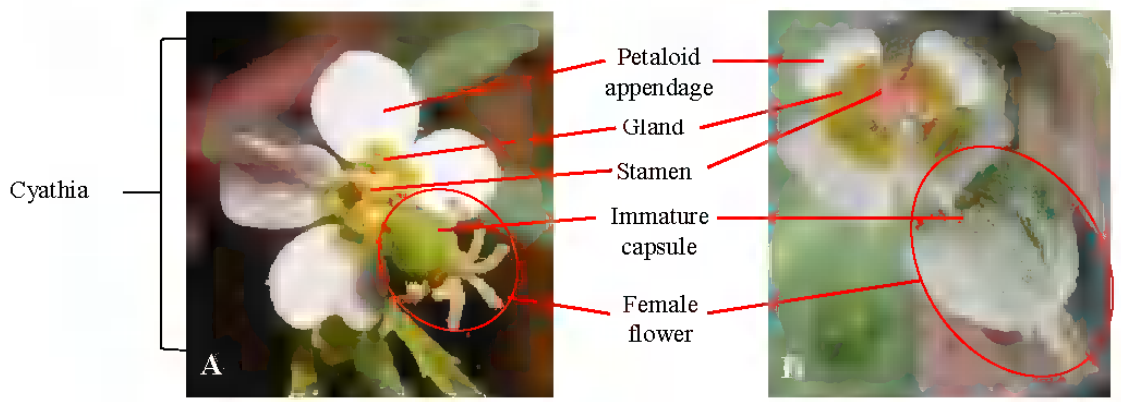

Figure 9. Cyathia of *Euphorbia*. (A) *E. florida*, each stamen is a male flower (from photo by Patrick Alexander; Centro Ecológico de Sonora, Hermosillo, 28 Oct 2006). (B) *E. pediculifera*, I-10 frontage road in Pima County 5–6 mi W of Cochise Co. line, 10 Aug 2014 (photo by Nathan Taylor).

Euphorbia is distributed worldwide with at least 2000 species and amazingly diverse growth forms, including the varied succulents of southern Africa; it is one of the world's largest genera along with *Astragalus* and *Carex* (Frodin 2004). The genus has traditionally been classified into five fairly well-marked major taxa, variously treated as subgenera or separate genera, four of them in the flora area: *Agaloma, Chamaesyce, Esula*, and *Poinsettia*. Current consensus recognizes a single, giant but monophyletic genus (e.g., Horn et al. 2012; Yang & Berry 2011). Although controversy for lumping or splitting of *Chamaesyce* and *Euphorbia* spanned more than a century, molecular phylogenetic studies place *Chamaesyce* well nested in *Euphorbia* (e.g., Steinmann & Porter 2002; Yang et al. 2012). Extensive phylogenetic studies of *Euphorbia* taxa worldwide resulted in defining four major clades or subgenera, but with alignments quite different from the traditional five subgenera (e.g., Horn et al. 2012, Yang & Berry 2011, and Yang et al. 2012). *Euphorbia* species in southwestern Arizona are in two subgenera: *Esula*, with a single species in the flora area, and *Chamaesyce*, a greatly expanded but monophyletic subgenus that includes the traditional *Chamaesyce* as well as *Agaloma* and *Poinsettia*. Spurges in southwestern Arizona are distributed among the following monophyletic taxa:

Subgenus **Chamaesyce**
- Section **Anisophyllum**
  - Subsection **Hypericifoliae** (14 species)
- Section **Poinsettia**
  - Subsection **Erianthae**: *E. eriantha*
  - Subsection **Exstipulatae**: *E. exstipulata*
  - Subsection **Stormieae**: *E. heterophylla*

Subgenus **Esula**, section **Helioscopia**: *E. spathulata*

1. Plants glabrous or pubescent; leaves variable, mostly petioled; cyathia variously colored, solitary or clustered; petaloid appendages present or absent; ovaries and capsules not warty; seeds 0.7–4 mm long, with or without a caruncle; widespread. ..... **Euphorbia** subgenus **Chamaesyce**
1. Plants glabrous; leaves sessile, obovate to broadly oblong, rounded or blunt at the tip; cyathia green to yellow-green, solitary in the axils of a pair of opposite leaves; petaloid appendages absent; ovaries and capsules conspicuously warty; seeds 1.5–2 mm long, with a minute white caruncle; in the flora area known only from Las Playas in Cabeza Prieta…….…… **Euphorbia** subgenus **Esula**

Euphorbia subgenus **Chamaesyce**

Subgenus "*Chamaesyce* contains around 600 species and includes the largest New World radiation within the Old World-centered genus *Euphorbia*. It is one of the few plant lineages to include members with C_3, C_4, and CAM photosynthesis, showing multiple adaptations to warm and dry habitats. This subgenus includes North American-centered groups that were previously treated at various taxonomic ranks under the names of '*Agaloma*', '*Poinsettia*', and '*Chamaesyce*'" (Yang et al. 2012: 764). Two of the 15 sections of subgenus *Chamaesyce* occur in southwestern Arizona.

1. Plants with sympodial growth; stems having obvious upper (dorsal) and lower (ventral) sides; leaves opposite, the blades asymmetric basally; stipules present (minute in *E. arizonica* and *E. setiloba*); seeds 0.7–2.6 mm long, lacking a caruncle.
…….... **Euphorbia** section **Anisophyllum**
1. Plant growth not sympodial; stems not having obvious upper (dorsal) and lower (ventral) sides; at least some leaves alternate (or opposite in *E. exstipulata*), the blades symmetrical; stipules absent or glandular; seeds 3–4 mm long (2–3 mm in *E. exstipulata*), with or without a caruncle.
..... **Euphorbia** section **Poinsettia**

Euphorbia section **Anisophyllum** subsection **Hypericifoliae**

Annual or perennial herbs (those in the flora area) and rarely shrubs. Two subsections of *Anisophyllum* are recognized and all but 3 species (not in the flora area) are in subsection *Hypericifoliae*.

These plants have sympodial growth, a specialized growth form with early abortion of the main shoot: the apical meristem of the main stem of the seedling aborts above the cotyledon node and the plant develops from lateral branches, and these lateral shoots branch dichotomously (e.g., Hayden 1988; Koutnik 1987; Yang et al. 2012). This growth form is a synapomorphy for section *Anisophyllum*, in which essentially the entire plant body resembles a synflorescence (Yang et al. 2012: 775). No other group in the Euphorbia family has this growth form. This branching pattern contributes to the prostrate or flat, spreading habit of growth seen in some of the species. Characteristics of *Anisophyllum* include C_4 photosynthesis, stems having obvious upper (dorsal) and lower (ventral) sides, opposite leaves and leaf blades with asymmetric bases, and presence of stipules (minute in *E. arizonica* and *E. setiloba*), seeds without a caruncle. Other features include leaves petioled although the petioles are sometimes very short, stipules on the ventral side of the stem often different from ones on the dorsal side, and cyathia with 4 glands (those in the flora area; sometimes 5–7 elsewhere).

Hypericifoliae is worldwide with about 360 species, and constitutes the largest lineage of C_4 plants among the eudicots (Yang & Berry 2011). Dark green veins that are associated with Kranz anatomy and often visible on C_4 leaves are prominent in many of the local species (Figure 10). These Kranz lines appear as dark veins alternating with light-colored stripes angling from the midvein toward the leaf margins and apex. Yang et al. (2012: 774) point out, "Together with juvenile flowering, copious seed production, and C_4 photosynthesis, sect. *Anisophyllum* has been very

successful in colonizing warm and semi-desert areas and disturbed habitats worldwide." And we add that it has also been successful in desert habitats.

Figure 10. *Euphorbia prostrata* leaf displaying Kranz anatomy; Lamesa, Dawson Co., TX, 11 Oct 2011, photo by Nathan Taylor).

Hypericifoliae species are common across the Sonoran and Chihuahuan deserts, with 33 species in the Sonoran Desert (Wheeler 1936, 1941; Wiggins 1964) and 13 species in the flora area. Most of the Sonoran Desert species can be readily identified by their distinctive seeds (Figure 11). Seeds of *E. micromera* and *E. polycarpa*, however, appear indistinguishable from each other. As in the case of *Cryptantha* sensu lato (Boraginaceae; e.g., Felger et al. 2015), rather technical and microscopic features are used in the keys, but with a little practice one can distinguish the species by the gross appearance of the plants. Those in the flora area are distinct from one another, with no indication of intermediates or hybrids, although several species often occur together. In Mexico these plants are generally known as *golondrina* (Spanish for "swallow," but the association with this bird is not known) and the general Hia-Ced O'odham name is vi'ibam (see *E. polycarpa*).

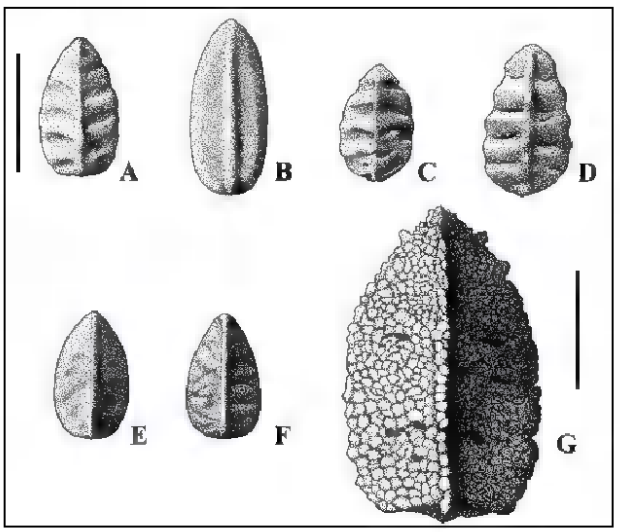

Figure 11. *Euphorbia* (Hypericifoliae) seeds. (A) *E. abramsiana*; (B) *E. albomarginata*; (C) *E. arizonica*; (D) *E. pediculifera*; (E) *E. polycarpa*; (F) *E. setiloba*; (G) *E. trachysperma*. By Matthew B. Johnson. Bar = 1 mm.

Pubescence, growth form, and color can be highly variable and all of the perennial species can flower in their first season. For example, *E. micromera* and *E. polycarpa* plants may be green or reddish, ephemeral to perennial, and glabrous or variously pubescent. *Euphorbia micromera* has cyathia without petaloid appendages, and appendages are lacking or reduced on *E. abramsiana, E. hyssopifolia, E. prostrata,* and *E. trachysperma*. Others, such as *E. melanadenia* and *E. polycarpa*, generally have conspicuous petaloid appendages, although young, developing cyathia and drought-stressed plants may have greatly reduced or no appendages. Color or color patterns often can be helpful for identification, but may also be variable with season, and even between individual plants at the same place and time. *Euphorbia abramsiana* and *E. micromera* usually have ovaries and capsules with well-defined red stripes or lines along the angles (keels) and furrows (the crease where the capsule splits, the carpel margins) and similar coloration is often seen on *E. albomarginata, E. pediculifera, E. polycarpa*, and some others. This red color is not seen on *E. hyssopifolia* and *E. trachysperma*, the two species with robust ascending growth.

The Hypericifolia tend to be pollination generalists; the major pollinators are probably small bees, wasps, and flies, but ants and butterflies also do their share (e.g., Krombein 1961; Webster 1994). Rutman found flowering *E. albomarginata* to have a fairly strong fragrance and on the same day (7 Mar 2015) observed flowering *E. polycarpa* swarming with small flying insects as well as ants. However, at least some hypericifolia are self-pollinating, especially the weedy ones, and presumably the majority of the species are self-compatible (e.g., Ehrenfeld 1976, 1979). It is an attractive hypothesis that there is a trend for species with reduced appendages to be selfing and those with larger appendages to be outcrossing and fragrant.

Most of the species in the Hypericifolia clade possess a seed coat that becomes mucilaginous and sticky when wet (e.g., Jordan & Hayden 1992; Pammel 1891), and this type of seed coat is otherwise rare in the *Euphorbia* genus (Yang and Berry 2012). Mucilaginous seed coats occur in many other angiosperm families (e.g., Polemoniaceae, Lindley 1828) and have been shown to facilitate seed hydration and germination as well as seed dispersal, including possible long-distance dispersal (e.g., Ebrahimzadeh et al. 2000; Gutterman & Shem-Tov 1997; Penfield et al. 2001).

Seeds of all Hypericifolia species in the flora region produce varying amounts of mucilage when wet, with the notable exception of *E. platysperma* (see species accounts). Upon drying this mucilage makes the seed adhere tenaciously to the substrate. Put a drop of water on one of these seeds and usually within 10 seconds a "slime jacket" forms and hair-like mucilaginous strands spring out, looking like fungal hyphae (use a dissecting or compound microscope, or even a hand lens). This "mucilaginous layer can reform repeatedly under alternating cycles of wet and dry conditions" (Jordan & Hayden 1992: 83). Even 1200-year-old seeds of *E. hyssopifolia* from a packrat midden became mucilaginous when wet (see species accounts).

These herbaceous euphorbias have an extensive history of medicinal use (e.g., Felger 2007; Felger & Moser 1985; Hrdlička 1908; Kearney & Peebles 1960; Moerman 1998). A few regional examples are given here. The Cahuillas made a decoction of the plant as a febrifuge and to treat chicken pox and smallpox, and an infusion was drunk to treat sores of the mouth (Bean & Saubel 1972). Use of these euphorbias to treat rattlesnake bite was widespread, and probably the source for the name rattlesnake weed for *E. albomarginata*. Among the Cahuillas a decoction was taken internally, or more commonly a poultice of the plant was applied to the snakebite (Bean & Saubel 1972). Describing the site of Fort Yuma in 1854, Lt. Nathaniel Michler (1987: 101) wrote that "euphorbia, a rank poison…[was] used by the Indians as an antidote against the bite of the rattlesnake." These spurges were also used to treat cuts, earaches, infections, sores, wounds, the bites of black widows and other spiders, and the stings of carpenter bees and honey bees (Bean & Saubel 1972; Cruz Matus, pers. comm. to Felger, unpublished notes of 1985 interview in Guaymas, Sonora;

Train et al. 1941; Zigmond 1981). Among the Gila River Pimas the plant was chewed as a laxative, but using too much would make one sick, and it was used in the same manner to eliminate intestinal worms (Rea 1997). The Seris mashed fresh herbage (mostly from *E. polycarpa*) with salt and oil and applied it as a poultice to swollen areas. They also used the plant to treat toothache or heart pain (Felger & Moser 1985). Cruz Matus (interview, 1985) in Guaymas, explained that the Yoemem (Yaquis) stored the dried plant for future use or chopped it up green if needed immediately. However, caution is advised since many members of the spurge family are known to be toxic.

1. Cyathia in dense, subcapitate and leafless (cymose) clusters…… **Euphorbia capitellata**
1. Cyathia mostly solitary, or sometimes few in the axils of leafy shoots.

2. Plants glabrous; stems orange, often with adhering sand; seeds 2.4 × 1.4 mm, grayish white, smooth on both sides, the inner face flat, smooth; restricted to windblown sands …….... **Euphorbia platysperma**
2. Plants glabrous or not; stems not orange and without adhering sand; seeds less than 2 mm long or if 2 mm or more then about as wide as long, whitish, brown, or black; not restricted to windblown sands.

3. Plants glabrous (or at least the capsules, or sometimes with a few stringy hairs at or near the nodes), often with one or a few erect or upright main axes; seeds 1.3–2.6 mm long, chunky, about as wide as long.

4. Leaves linear (conspicuously slender); petaloid appendages conspicuous; seeds 1.7–2 mm long, smooth between 2 or 3 low, transverse ridges…… **Euphorbia florida**
4. Leaves lanceolate to oblong; petaloid appendages mostly not conspicuous or absent; seeds 1.3–2.6 mm long, with few, shallow, transverse depressions or granulated.

5. Seeds 1.3–1.4 mm long, usually blackish at maturity, the faces with shallow transverse ridges (usually 3 or fewer)…….... **Euphorbia hyssopifolia**
5. Seeds 2–2.6 mm long, usually gray to brown at maturity, the faces granulated and without transverse ridges……..... **Euphorbia trachysperma**

3. Plants glabrous or pubescent, generally with several to many spreading to prostrate major stems; seeds 1.5 mm or less in length, longer than wide (except *E. hyssopifolia*).

6. Plants glabrous; stems often rooting at nodes; leaf blades all or mostly orbicular or nearly so; stipules conspicuous, usually white, and united into membranous scales. ……..…….. **Euphorbia albomarginata**
6. Plants glabrous or pubescent; stems not rooting at nodes; leaf blades usually not orbicular, often ovate to obovate or oblong; stipules slender and inconspicuous or minute and not readily visible.

7. Petaloid appendages absent or sometimes minute; involucral glands about 0.1–0.6 mm wide.

8. Seed surfaces smooth or faintly wrinkled.

9. Involucral glands round, dot-like, 0.12–0.25 mm wide; stamens 2–5 per cyathium. …… **Euphorbia micromera**
9. Involucral glands oval, 0.3–0.6 mm or more in width; stamens 15 or more per cyathium…….. **Euphorbia polycarpa**

8. Seed surfaces with transverse ridges.

10. Leaves oval to oblong; capsules hairy (only or mostly hairy on ridges, especially toward base of capsule); seeds 0.7–0.8 mm long, the margins, crest, and ridges sharp-angled (ragged)…… **Euphorbia prostrata**
10. Leaves oblong; capsules glabrous (or essentially glabrous in *E. abramsiana*); seeds 1–1.4 mm long, the margins, crest, and ridges smooth (not ragged).

11. Plants mostly spreading to prostrate; largest leaves usually less than 13 mm long; leaf margins usually toothed near apex and along longest side; involucral glands 0.1–0.15 mm wide; seeds 1–1.2 mm long, grayish white to brownish at maturity, with 4–6 ridges…….. **Euphorbia abramsiana**
11. Plants mostly erect to ascending; largest leaves usually over 13 mm long; leaf margins evenly serrated all around; involucral glands 0.2–0.4 mm wide; seeds 1.3–1.4 mm long, usually blackish at maturity, with usually 3 or fewer transverse ridges. …… **Euphorbia hyssopifolia**

7. Petaloid appendages present (sometimes not developed in young cyathia or drought-stressed plants; these plants key out in both choices); involucral glands various.

12. Plants glandular-pubescent and sticky to the touch; cyathia narrowed or constricted at apex.

13. Annuals or perennials; glandular hairs slightly enlarged (club-shaped) at tip; petaloid appendages entire or moderately lobed (rounded at tip)…..…… **Euphorbia arizonica**
13. Annuals; glandular hairs not enlarged at tip; petaloid appendages with triangular, pointed segments, the cyathia thus appearing star-shaped…….. **Euphorbia setiloba**

12. Plants glabrous or pubescent and sometimes glandular-pubescent but not sticky to the touch; cyathia not narrowed or constricted at apex.

14. Seed surfaces smooth or faintly wrinkled.

15. Herbage with evenly distributed appressed hairs, usually giving the plant a grayish appearance; ovaries and capsules densely hairy..... **Euphorbia melanadenia**
15. Herbage glabrous or with spreading hairs, not grayish in appearance; ovaries and capsules glabrous or sometimes sparsely pubescent……**Euphorbia polycarpa**

14. Seed surfaces with conspicuous transverse ridges and grooves.

16. Herbage, cyathia and capsules hairy; cyathia 1.2–1.5 mm wide, the glands 0.6–0.9 mm wide, the petaloid appendages usually 0.5 mm or more in width (rarely absent or reduced on immature cyathia) …….…… **Euphorbia peduliferа**
16. Plants glabrous, or hairy and capsules glabrous or glabrate; cyathia 0.4–0.9 mm wide, the glands 0.1–0.4 mm wide, the appendages to 0.4 mm wide (measured perpendicular to gland).

17. Plants mostly spreading to prostrate; largest leaves usually less than 13 mm long; leaf margins mostly toothed near apex and along longest side; seeds 1–1.2 mm long, about half as wide as long, ashy white to brownish at maturity, with 4–6 transverse ridges …….…… **Euphorbia abramsiana**

17. Plants mostly erect to ascending; largest leaves usually over 13 mm long; leaf margins evenly serrated all around; seeds 1.3–1.4 mm long, more than half as wide as long, usually blackish or dark gray at maturity, with 3 or fewer transverse ridges ……**Euphorbia hyssopifolia**

Euphorbia abramsiana L.C. Wheeler
[*Chamaesyce abramsiana* (L.C. Wheeler) Koutnik]
Desert sandmat, Abrams' spurge; *golondrina.* Figures 11A, 12.

Figure 12. *Euphorbia abramsiana.* (A & B) Why, 31 Jul 2014. (C) Near Bates Well, 16 Aug 2006. (D) Chico Shuni Wash near Chico Shuni Village, 5 Aug 2014.

Small, warm-weather ephemerals, sometimes still present in December, often forming prostrate mats with reddish-brown herbage in dry, open habitats, but upright to spreading and green among dense vegetation and in shaded places. Herbage with short white hairs usually on youngest growth, at the base of the plant, and on at least proximal portions of stems; the distal parts of the stems and herbage often glabrate or essentially glabrous, or the entire plant rarely glabrate (thus part of the plant may be pubescent and part may be glabrate or glabrous). Leaf blades 2.5–12 (14) mm long, elliptic to oblong, usually toothed near apex and along longest side, red-brown or green with one or more reddish botches near the center. The leaf margins tend to curl when drought stressed, giving the appearance of entire margins. Stipules white, fringed or ciliate, separate or narrowly fused at base. Cyathia 0.4–0.5 mm wide, the involucral glands dot-like (round or nearly so), 0.1–0.15 (0.2) mm wide, the appendages absent or to 0.2 mm wide, white or pink. Capsules glabrous (or essentially so), often bright green with red stripes at the angles and furrows. Seeds 1–1.2 mm long, about half as wide as long, ashy grayish-white to tan, with 4–6 transverse ridges; mucilaginous when moistened; the seeds, like various other Hypericifolia species, look like mealy bugs (Pseudococcidae) or beetle larvae.

Widespread across the flora area in many habitats and soils, including clay soils in playas and fine alluvium along washes to gravelly or rocky soils to desert pavement. Often growing with *E. polycarpa* and *E. micromera*. Seasonally common in many areas, including the large Cabeza Prieta playas near the Mexican border.

Southern Arizona to southern Trans-Pecos, Texas (along the Rio Grande in Big Bend National Park and Big Bend Ranch State Park), Sonora, Sinaloa, southeastern California, and much of the Baja California Peninsula.

OP: Aguajita, 13 Sep 1986, *Felger 86-277*. Near Gachado junction, *Wirt 25 Jul 1990*. Ajo Mountain Drive, 2 mi from Hwy 85, 530 m, xeroriparian, with *Euphorbia peditulifera, E. setiloba*, 12 Sep 2014, *Rutman 20140912-2*. 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Rd, 30 Sep 2006, *Rutman 20060930-3*.

CP: Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-658* (ARIZ, ASU). San Cristobal Wash, 14 Sep 1992, *Felger 92-684*. Las Playas, 28 Nov 2001, *Felger 01-577*.

TA: Coyote Water, 25 Oct 2004, *Felger 04-44*. Coyote Wash at Camino del Diablo, 25 Oct 2004, *Felger 04-68*.

Euphorbia albomarginata Torrey & A. Gray
[*Chamaesyce albomarginata* (Torrey & A. Gray) Small]
Rattlesnake weed; *golondrina*. Figures 11B, 13.

Herbaceous perennials from deeply set, thickened roots, and also flowering in the first season; stems prostrate-creeping, rooting at nodes, often locally carpeting the ground. Roots relatively large and rough, with adventitious roots at nodes, or where there are not roots on the nodes there are almost always (except in very young stems) bumps below the stipule representing the structure that can or will form adventitious roots. Plants glabrous. Leaf blades 2–8 mm long, broadly ovate to orbicular, often with a red blotch in the middle, the margins entire and often with a narrow white edge (hence the specific name). Stipules relatively large and conspicuous, usually white, united into a triangular scale with a fringed margin. Cyathia solitary at nodes, the involucres more than 1 mm wide. Glands (0.3) 0.5 mm or more wide (the smaller sizes might not be fully formed) and oval. Petaloid appendages white and conspicuous, wider and longer than the glands. Stamens (10) 15–30 per cyathium. Seeds 0.9–1.4 mm long, the dorsal side with a low ridge crest, moderately flattened on either side of the ridge, and excavated on both sides of the septum on the ventral surface; mucilaginous when moistened. Growing and flowering at various seasons.

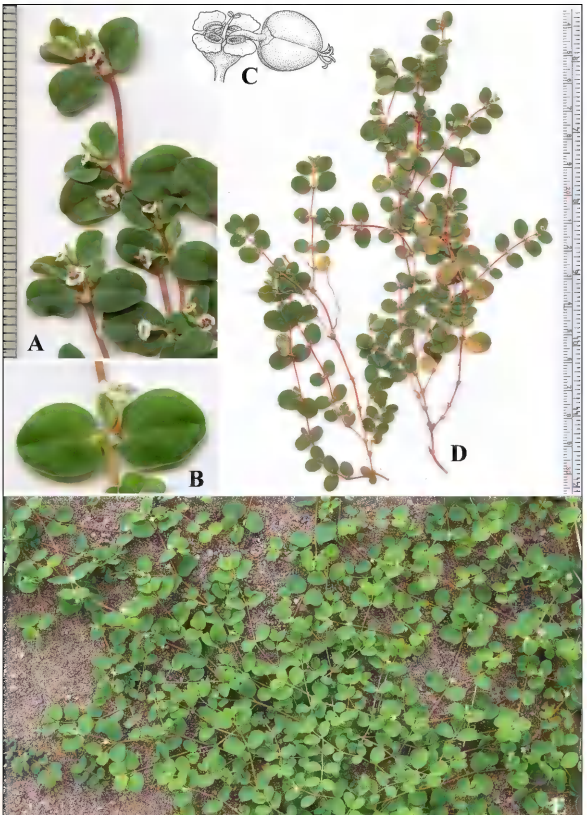

Figure 13. *Euphorbia albomarginata.* (A) Wash bed, Why, 3 Sep 2014. (B) Roadside, Hwy 86 E of Why, 11 Sep 2014. (C) By Lucretia Breazeale Hamilton. (D) Cuerda de Leña near N boundary of Organ Pipe, 12 Sep 2008. (E) Roadside, Hwy 86 east of Why, 1 Aug 2014.

Locally common in poorly drained, fine-textured, and often sandy-silty soils; playas, dirt tanks, washes and canyon bottoms, and roadside ditches. Widely scattered across the lowlands of much of the flora area.

Widespread in western North America.

OP: Bates Well, *Nichol 26 Apr 1939*. Senita Basin, *Warren 11 Aug 1975*. Growler Canyon, E. of Bates Well, sandy soil, 19 Mar 1975, *Lehto L18318* (ASU). Puerto Blanco Drive, 7.9 by road W of Visitor Center, 16 Oct 1977, *Bowers 893*.

CP: S19, T15S, R12W, sand, 5 Apr 1979, *Lehto L23475* (ASU). Las Playas, 31 Jan 1992, *Felger 92-16*. Jose Juan Tank, 12 Jun 1992, *Felger 92-569-C*. Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-659*. San Cristobal Wash, 14 Sep 1992, *Felger 92-687*.

The *Euphorbia serpens* species complex includes *E. serpens*, its sister species *E. albomarginata*, and five other species that appear to involve *E. serpens* as one of their parents. These species form a complex inferred to have highly reticulate evolutionary relationships (Yang & Berry 2011: 1498). *Euphorbia serpens* Kunth, a worldwide and often weedy spurge, resembles and is often confused with *E. albomarginata*. Surprisingly, we have not found any verifiable specimens of *E. serpens* from Arizona: specimens from Arizona previously labeled as *E. serpens* have turned out to be *E. albomarginata*. *E. serpens* is annual, although it sometimes can overwinter; unlike *E. albomarginata*, the roots are smooth and not knotty. The leaves of *E. albomarginata* usually are larger and more circular than those of *E. serpens*, but some *E. albomarginata* specimens have smaller leaves than those of most *E. serpens* specimens. *E. serpens* has smaller involucres and smaller glands, and fewer stamens, which is the most reliable key character. They can be distinguished as follows:

1. Perennials; involucres usually more than 1 mm wide, petaloid appendages usually conspicuous; stamens (10) 5–30 per cyathium ..... **E. albomarginata**
1. Annuals; involucres 0.6 to less than 1.0 mm wide; appendages inconspicuous; stamens (2) 3–5 per cyathium ..... **E. serpens**

Euphorbia arizonica Engelmann
[*Chamaesyce arizonica* (Engelmann) Arthur]
Arizona spurge; *golondrina*. Figures 11C, 14.

Herbaceous perennials, often mound-shaped, and also flowering in the first season. Plants, including cyathia and capsules, conspicuously pubescent, the hairs glandular and slightly enlarged at the tip with several septa between red bead-like segments. Herbage often reddish, especially when drought- or cold-stressed. Leaves short petioled, the blades 1.2–8.5 mm long, mostly broadly ovate, or nearly orbicular or oblong, the margins entire; stipules minute (often not readily apparent). Involucres narrowly urceolate (urn shaped), taller than wide, 0.8–1.6 mm long, slightly narrowed at apex just below the glands, pink to reddish; appendages petal-like, conspicuous, wider than the glands, white, becoming dark pink with age, the margins entire or shallowly lobed. Seeds 0.9–1.1 mm long, chunky, transversely ridged, mucilaginous when wet.

Rocky habitats and canyons in the Ajo Mountains and probably elsewhere in Organ Pipe.

Southern California to west Texas, south to Baja California Sur, southern Sonora, and Durango.

The cyathia are similar to those of *E. setiloba* except larger and the petaloid appendages entire or shallowly lobed rather than laciniate-margined. The minute stipules, reddish herbage,

glandular pubescence, and conspicuous bright white or pink appendages serve to distinguish *E. arizonica*. The reduction of stipules is an unusual feature among the *Hypericifoliae* and one shared with *E. setiloba*. Taylor reports, "In both species the stipules are reduced to a small flap over the node, the same color as the stem, and appressed to the point of being nearly invisible. They range from whitish to purple to dark purple. And, on some, no matter how hard I tried, I was unable to make them out through the dense glandular hairs. The best specimens to see them on are the ones that are etiolated. If you can't find one that is etiolated, try the very apex of the stems on both sides. In *E. arizonica* the flap is pretty much always present." The seeds of *E. arizonica* are similar to those of *E. abramsiana* but differ in being slightly smaller and having deeper and more irregular furrows.

Figure 14. *Euphorbia arizonica*. (A) Bull Pasture Trail, 19 Sep 2014. (B & F) Alamo Wash near Hwy 85 bridge, 2 Aug 2014. (C & D) Billings Vista, Burro Mts, Grant Co., NM, 20 Jul 2009, photos by Russell Kleinman (gilaflora.com). (E) Alamo Wash near confluence with Tillotson Wash, 2 Nov 2013.

OP: Alamo Canyon: *Nichol 14 Mar 1939*; Wash E of Cement Tank, 10 Oct 1978, *Sutherland 4*; 16 Feb 1979, *McLaughlin 1934*. Bull Pasture Trail, 5 Nov 1977, *Bowers 948*. Estes Canyon, 2500 ft, 11 Apr

1978, *Bowers 1238* (ORPI). Arch Canyon, immediately below the arch, 900 m, 2 Dec 1990, *Felger 90-527*.

Euphorbia capitellata Engelmann
[*Chamaesyce capitellata* (Engelmann) Millspaugh] Figure 15.

Figure 15. *Euphorbia capitellata*. Alamo Wash at Hwy 85 bridge: (A–C) 2 Aug 2014; (F) 2 Aug 2014. (D) Estes Canyon along trail to Bull Pasture, 8 Sep 2014. (E) Wash crossing Hwy 85 at mile 66.5, 0.5 mi S of Alamo Wash, 2 Aug 2014.

Herbaceous perennials with a stout tap root. Herbage pubescent, glabrate, or glabrous especially with age. Leaf blades mostly 4–22 mm long, green, often with reddish blotches in the middle, markedly asymmetrical, ovate to linear lanceolate, often falcate, serrate along the lower margins, or remotely serrate, or entire; leaves becoming reddish when drought stressed. Stipules narrow, ciliate, and separate. Cyathia in dense clusters at stem tips; petaloid appendages white to sometimes pink and much wider than the glands. Ovaries and capsules pubescent, glabrate, or glabrous. Seeds 1.2–1.4 mm long, at first brown, becoming grayish-white, and sharply angled with low transverse ridges; highly mucilaginous when wet. Flowering at any season except during extreme drought.

Gravelly washes and lower slopes in the Ajo and Diablo mountains.

Arizona to Texas, and Sonora to Coahuila, Durango, and the Baja California Peninsula.

OP: Cement Tank [Alamo Canyon], *McDougall 14 Apr 1941*. Rocky slopes 6.7 mi by road NE of Visitor Center along Ajo Mt Drive, 2000 ft, 5 Nov 1977, *Bowers 922* (ORPI). Estes Canyon picnic site, *Beale 15 Feb 1987* (ORPI). Low- to mid-bajada of the Ajo Mts, 2114 ft, abundant in the sand and gravel drainage bed, 2 Apr 2003, *Rutman 2003-448*.

Euphorbia florida Engelmann
[*Chamaesyce florida* (Engelmann) Millspaugh] Figures 9, 16.

Warm-weather annuals, to 50 cm tall, glabrous, the stems erect to ascending, and especially the upper stems very slender. Leaf blades notably slender, linear to sometimes narrowly lanceolate, 5–50 × 0.5–2.5 (5.5) mm; the margins minutely toothed and becoming revolute in age. Stipules 1–2 mm long, slender and separate, usually fringed. Petaloid appendages conspicuous, larger than the glands, white and often becoming pink with age. Seeds 1.7–2 mm long, chunky, grayish white, the faces relatively smooth with 1–few low transverse ridges; mucilaginous when wet.

Major washes, sandy flats, and canyon bottoms. Widely scattered across much of Organ Pipe in the Arizona Upland areas and major washes on the east side of Cabeza Prieta; often locally common, such as in washes and grassy area in the north-central part of Organ Pipe.

Arizona to Jalisco and Chihuahua.

OP: Alamo Canyon, bottom, 28 Aug 1943, *Clark 10943* (ORPI). Near Dripping Springs, *Galiano 21 Aug 1986* (ORPI). 1.5 mi W of State Rte 85, and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 10060830-1*. 0.8 km E of summit of Twin Peaks, 1740 ft, 1 Aug 1990, *Baker 7884* (ASU, ORPI). N end of Bates Mts, 437 m, 11 Sep 2013, *Rutman 20130911-1*. Arch Canyon, N of the arch, *Rutman 12 Sep 2014*.
CP: Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-660*.

Euphorbia hyssopifolia Linnaeus
[*Chamaesyce hyssopifolia* (Linnaeus) Small]
Hyssop spurge. Figure 17.

Warm-weather ephemerals, glabrous or sometimes sparsely pubescent, often with an erect main axis or several ascending major branches, to ca. 60 cm tall. Leaves 4–20 (30) mm long (larger leaves usually 13 or more mm long), lanceolate to oblong, sometimes with a red blotch or blotches in the center, the margins evenly serrated. Stipules ca. 1 mm long, triangular and moderately fringed, and separate or fused basally. Cyathia 0.4–0.9 mm wide, the involucral glands 0.2–0.4 mm wide, oval, pink to maroon; petaloid appendages absent or 0.3–0.6 mm wide, broader than long, white or pink, darkening with age. Seeds 1.3–1.4 × 1 mm, corpulently ovoid, at first grayish and usually becoming blackish, the angles rounded, and with a few shallow transverse depressions; mucilaginous when wet, even when 1200 years old, and adhering tenaciously after drying.

Widely scattered in Organ Pipe and the east side of Cabeza Prieta. Bajadas, canyons, large washes, rocky slopes, and mountains. It has been the Ajo Mountains for at least 1200 years. The fossil seeds produced mucilage when immersed in water.

Arizona to southeastern United States and South America; also adventive in the Old World.

OP: Alamo Canyon, ¼ mi SE of corral, along main wash, *Wirt 27 Jul 1990*. Bull Pasture, *Wirt 13 Aug 1990* (ORPI). Growler Valley, near intersection of Bates Well Road and historic Palo Verde Camp Road, 8 Oct 2006, *Rutman 20061008-7*. Saddle between Arch and Boulder canyons, 26 Oct 2003, *Rutman 20031026-18*. †Alamo Canyon, capsule with 3 seeds, 1150 ybp.

CP: Daniels Arroyo, 26 Sep 1992, *Harlan 309*. Growler Valley, San Cristobal Wash where the Camino del Diablo/Bates Well Road crosses the wash, 318 m, 26 Sep 2013, *Rutman 20130926-6*.

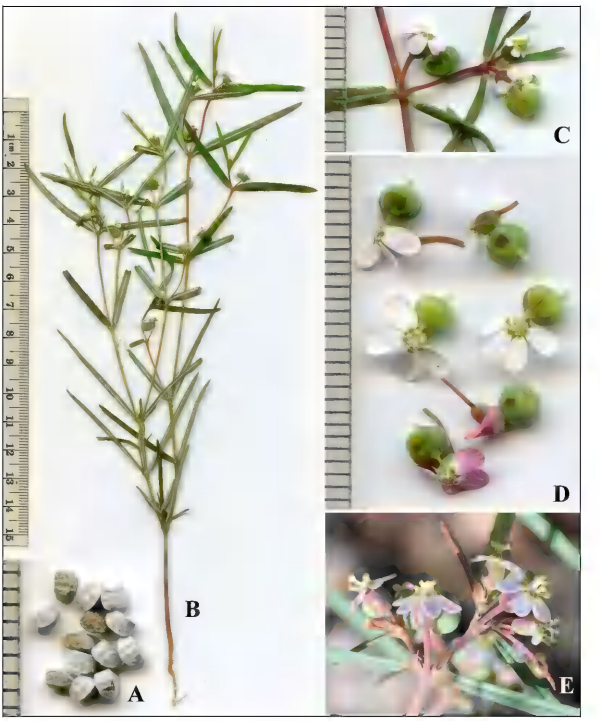

Figure 16. *Euphorbia florida*. (A) Diablo Mts, N end of Ajo Mountain Drive, 30 Sep 2014. (B) Cuerda de Leña, 4 Aug 2014. (C & D) Roadside ditch, Hwy 86 between Why and Pisinimo, Pima Co., 23 Aug 2014. (E) Wash crossing the northern Ajo Mountain Drive, Diablo Mts, 12 Sep 2013.

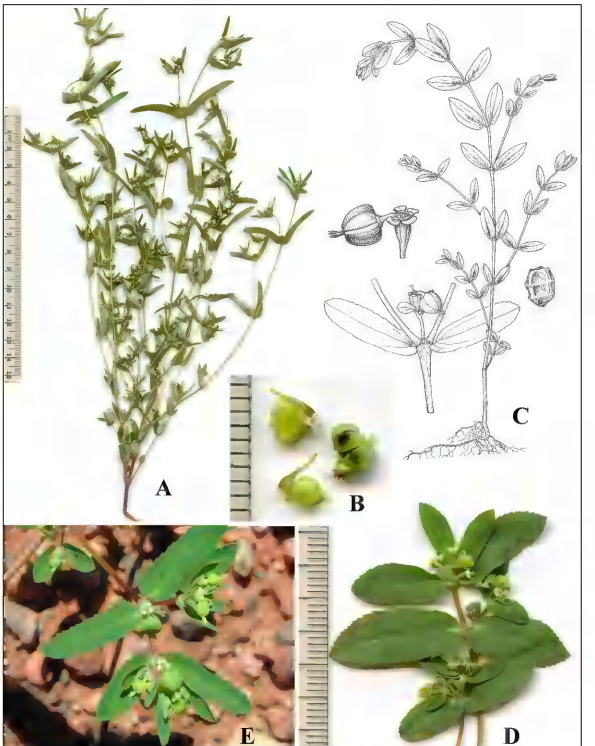

Figure 17. *Euphorbia hyssopifolia*. (A) Estes Wash near Ajo Mountain Drive, 26 Aug 2014. Roadside ditch, Hwy 86 between Why and Pisinimo: (B) 23 Aug 2014; (D) 1 Aug 2014. (C) By Lucretia Breazeale Hamilton. (E) Sedona, Yavapai Co., 15 Aug 2011, photo by Max Licher (SEINet).

†**Euphorbia melanadenia** Torrey
[*Chamaesyce melanadenia* (Torrey) Millspaugh]
Golondrina. Figure 18.

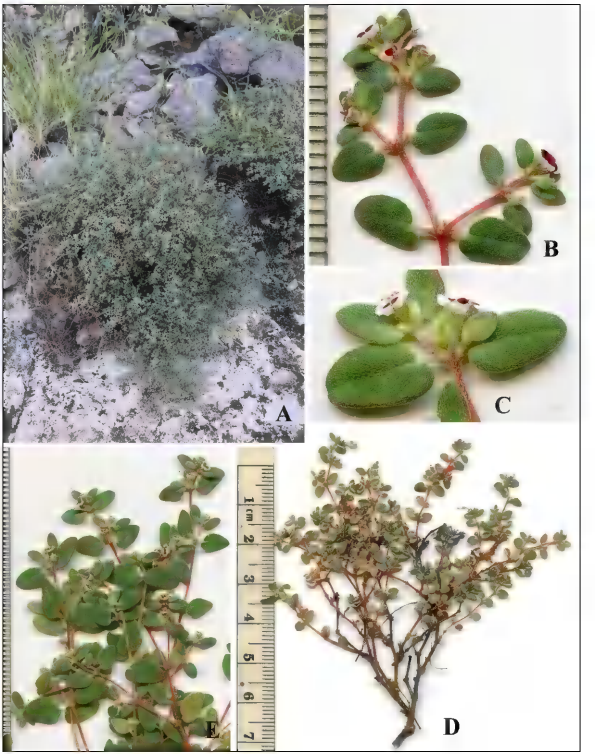

Figure 18. *Euphorbia melanadenia.* (A, C, & D) Arch Canyon, 12 Sep 2014. (B) Wash crossing N end of Ajo Mountain Drive, 26 Aug 2014. (E) Bull Pasture Trail, 8 Sep 2014.

Small, densely branched perennial herbs, new growth often tomentose, with grayish appressed hairs and sometimes becoming glabrate with age, the herbage usually purplish-gray. Leaf blades 3–8 mm long (to 16 mm long on well-watered, vigorous new growth of first season plants), ovate to lanceolate, the margins entire. Stipules ca. 1 mm long, slender and separate on the dorsal side of the stem, those on the ventral side united basally. Cyathia broad with dark maroon glands (oval, wider than long) and with conspicuous white petaloid appendages (often not present on young, developing cyathia), usually broader (often much broader) than the glands and often notched at the tip; ovaries densely pubescent, the capsules pubescent. Seeds 1.1–1.5 mm long, elongated, and smooth to faintly wrinkled, and mucilaginous. This spurge usually is readily recognized by the grayish or reddish-gray herbage, appressed hairs, and showy petaloid appendages.

Ajo Mountains and probably the Diablo Mountains; canyon bottoms to rocky slopes from low to high elevations, often on thin soils or bedrock growing among *Selaginella*. A leaf from a packrat midden more than 8000 years old had intact pubescence allowing identification.

Central and southern Arizona and northern Sonora, and disjunct in southern California, Baja California, and Baja California Sur.

OP: Alamo Canyon: *Tinkham 19 Apr 1942*; 2 Feb 1946, bed of canyon, *Goodding 7-46*; bed of wash, 9 Mar 1946, *Goodding 10-46*. Bull Pasture Trail, ca. 3000 ft, *Bezy 25 Oct 1964*. Middle bajada, Ajo Mts, 2 Apr 2003, *Rutman 2003-448*. Trail from The Cones to Mount Ajo, 3940 ft, 10 Apr 2005, *Felger 05-263*. †Alamo Canyon, leaf, 8130 ybp.

Euphorbia micromera Boissier
[*Chamaesyce micromera* (Boissier) Wooton & Standley]
Golondrina. Figure 19.

Small herbaceous perennials or mostly non-seasonal ephemerals, resembling *E. polycarpa*. Glabrous or often hairy, especially the capsules and new growth. Leaf blades 1.2–5 mm long (larger leaves often few in number and on larger stems near the center or base of the plant), mostly broadly ovate to oblong, the margins entire. Stipules linear and ciliate; fused basally on the ventral side, separate on the dorsal side. Involucre usually less than 1 mm wide, the glands 0.12–0.25 mm wide, dot-like, rounded, maroon, without petaloid appendages. Stamens 2–5 per cyathium. Capsules often with red stripes at the angles and furrows. Seeds 0.9–1.0 mm long, resembling those of *E. polycarpa*, mucilaginous when wet.

Common in many habitats including washes, plains, bajadas, and rocky slopes. Widespread in Organ Pipe and Cabeza Prieta.

Southeastern California to Utah and west Texas, Baja California, northern Sonora, and the Chihuahuan Desert in north-central Mexico.

There is little to distinguish *E. micromera* from *E. polycarpa* except the consistent absence of petaloid appendages on the cyathia; the smaller, rounded, dot-like rather than oval glands; and fewer stamens. Although most *Chamaesyce* have distinctive seeds, those of *E. micromera* and *E. polycarpa* appear identical. *E. micromera* has been reported to be annual (ephemeral) and *E. polycarpa* perennial, but both occur as ephemerals/annuals or perennials. *E. micromera* ranges farther north than does *E. polycarpa*, and *E. polycarpa* ranges farther south than does *E. micromera*. *E. micromera* tends to be more numerous in relatively more arid habitats, whereas *E. polycarpa* tends to be more numerous in somewhat less arid habitats. Especially in arid situations, *E. polycarpa* may produce plants lacking petaloid appendages, and the glands may be smaller than usual, but they are oval, whereas those of *E. micromera* are round and dot-like. *E. micromera* produces 2–5 stamens per

involucre while *E. polycarpa* may have 15–32 stamens per involucre. Although counting the exact number of stamens may be difficult, you usually can find the approximate number: Even after the anthers fall away, the male flower stalks (pedicels and filaments) and/or their stubs usually remain and can be seen with magnification.

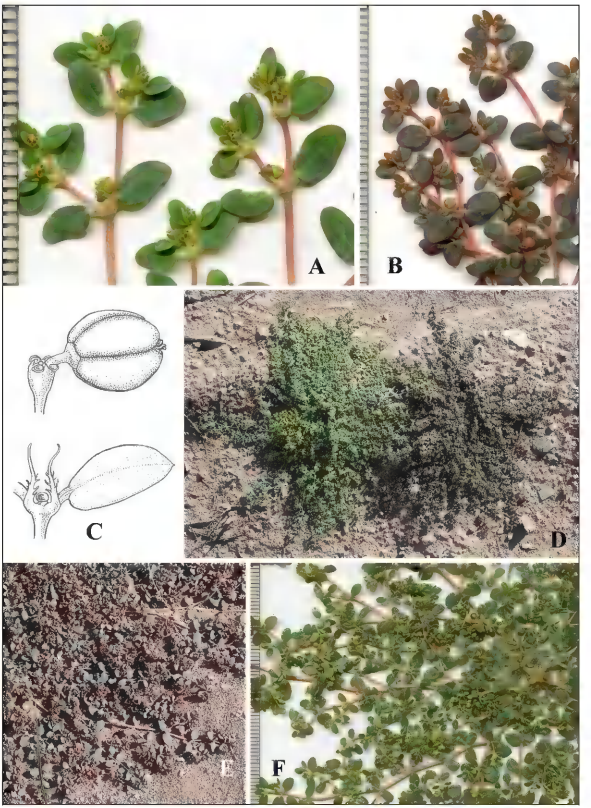

Figure 19. *Euphorbia micromera*. (A & F) Alamo Wash near Hwy 85 bridge, 9 Aug 2014. (B) Kuakatch Wash near Hwy 85, 11 Aug 2014. (C) Cyathium with capsule (above) and a node with stipules, by Lucretia Breazeale Hamilton. (D & E) Two color morphs, Knucklehead Wash, base of Childs Mountain, 5 Sep 2014.

Plants of *E. parishii* Greene, known from deserts in southeastern California, resemble both *E. micromera* and *E. polycarpa*. However, Yang and Berry (2012) show that *E. parishii* is not especially close to them phylogenetically. Like *E. micromera*, *E. parishii* lacks petaloid appendages but is more like *E. polycarpa* in having glands 0.5 mm wide. *E. parishii* is reliably distinguished by having 40–50 stamens per cyathium.

OP: Armenta Well, *Warren 16 Nov 1974*. Aguajita, 13 Sep 1986, *Felger 86-294*. Armenta site, 2 mi W of Hwy 85, *Wirt 8 Sep 1990*. 1.5 mi W of State Rte 85 and S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-9*.

CP: Christmas Pass, 14 Apr 1992, *Harlan 276* (CAB). Packrat Hill, 25 Sep 1992, *Harlan 300*. Little Ajo Mts, Copper Canyon at Charlie Bell Road, xeroriparian, 24 Aug 2014, *Rutman 20140824-19*.

†Euphorbia micromera and/or **E. polycarpa**

One or both of these species was in the Tinajas Altas Region more than 10,000 years ago.

TA: †Butler Mts, capsules, seeds, 8160 & 10,360 ybp.

Euphorbia pediculifera Engelmann var. **pediculifera**

[*Chamaesyce pediculifera* (Engelmann) Rose & Standley var. *pediculifera*]

Louse spurge; *golondrina*. Figures 11D, 20.

Non-seasonal ephemerals to short-lived perennials, spreading to prostrate with age. Young herbage, capsules, and cyathia densely pubescent, the hairs relatively thick, short, white, and appressed to spreading, the herbage sometimes becoming glabrate with age. Herbage often reddish brown to gray-brown, especially in dry seasons. Leaf blades usually at least twice as long as wide, 5.5–15.5 mm long, ovate to obovate or oblong, the margins entire or sometimes with a few small, irregular teeth. Stipules on dorsal side of stem slender and separate, those on the ventral side united basally. Cyathia 1.2–1.5 mm wide, the glands usually maroon (or yellowish with summer rains), oval, 0.6–0.9 mm wide, the appendages conspicuous, wider and longer than the glands, sometimes 2–2.5 × 1–1.2 mm, white, becoming pink with age. Capsules sometimes with red stripes at the angles and furrows. Seeds 1–1.2 mm long, chunky, encircled by conspicuous transverse ridges, the dorsal ridge rounded and somewhat flattened; mucilaginous when wet.

Organ Pipe and at least the eastern half of Cabeza Prieta; widespread and common in many habitats including sandy gravelly washes, plains, and rocky slopes.

Sonoran Desert in California and Arizona, and southward to Sinaloa and the Cape Region of Baja California Sur. Another variety occurs in the Guaymas Region in Sonora.

OP: Quitobaquito: 30 Jan 1894, *Mearns 2746* (US); 13 Sep 1986, *Felger 86-278*. Bates Well, 16 Nov 1939, *Harbison 26146*. Twin Peaks, 2 Mar 1985, *Van Devender 85-5*.

CP: 14 mi W of Papago Well, 18 Feb 1979, *McLaughlin 1959*. Pinta Sands, *Mathes 21 Mar 1992* (ASC). Agua Dulce Spring, 14 Sep 1992, *Felger 92-733*. Charlie Bell Road near E Refuge boundary, 25 Feb 1993, *Felger 93-55*.

Euphorbia platysperma Engelmann ex S. Watson

[*Chamaesyce platysperma* (Engelmann ex S. Watson) Shinners]

Gran Desierto dune spurge. Figure 21.

Non-seasonal annuals to herbaceous perennials, with deeply buried roots and often dune-buried stems, forming loose, spreading mounds often 0.5–1+ m across. Plants glabrous; stems slender, flexible, pale orange, arching or ascending, becoming semi-prostrate with age, with sand adhering to the glandular-sticky buried portions of the stems and forming a sand jacket. Leaf blades often 5–16 × 2.2–7.2 mm, elliptic to oblong or obovate, relatively thin, the midrib prominent, the

margins entire. Stipules narrowly triangular and separate. Cyathia on prominent peduncles, solitary in the leaf axils, 1.2–1.8 mm wide, and yellow-green; glands 0.5–0.9 mm wide, yellowish-green, and darker and more prominent than the appendages; the appendages yellowish and shorter than the glands. Stamens ±50. Seeds 2.4 × 1.4 mm, slightly incurved near the tip, the dorsal side smooth, with or without a prominent medial ridge, the inner face flattened and smooth on either side of a prominent medial ridge; seeds not mucilaginous. Flowering in nearby Sonora recorded from October to May.

Figure 20. *Euphorbia pediculifera* var. *pediculifera*. (A) Cuerda de Leña near N boundary of Organ Pipe, 4 Aug 2014. (B) Wash at Hwy 85 mile 66.5, 0.5 mi S of Alamo Wash, 3 Sep 2013. (C) Kuakatch Wash at Hwy 85, 7 Sep 2014. (D) Wash draining Chuckwalla Hills, 2 mi from Hwy 85 on Ajo Mountain Drive, 12 Sep 2014. (E) Estes Canyon, 19 Sep 2014.

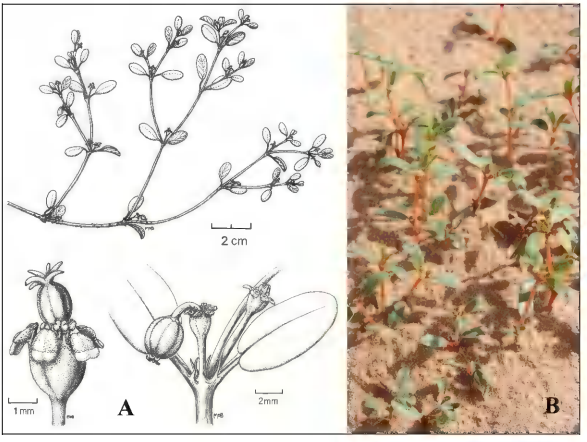

Figure 21. *Euphorbia platysperma*. (A) By Marlo Buchmann (from Felger 1980, 2000). (B) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 20 Feb 2005.

The main population occurs on dunes and adjacent windblown sands of the Gran Desierto of northwestern Sonora (Felger 2000). It scarcely extends into Arizona near the southwestern margin of the flora area west of the Tinajas Altas Mountains, and there is one record from Yuma. It is expected in the Pinta Sands of Cabeza Prieta along the Mexican border. Also occasional waifs recorded from windblown sands in southeastern California and northeastern Baja California.

Euphorbia platysperma has the smallest geographic range of any *Chamaesyce* in the Sonoran Desert and is the only member of the Hypericifolia clade in the flora area with non-mucilaginous seeds. A mucilaginous seed coat is also missing in inland Hawaiian species derived from ancestral, coastal species that have mucilaginous seeds (Jordan & Hayden 1992; Yang & Berry 2011). Loss of dispersibility has been shown to be an adaptive feature in many island taxa (e.g., Carlquist 1966, 1980) and the dune and windblown sand habitat of *E. platysperma* is seen as an island-like habitat within the desert. A similar sand-adapted species in Texas and the Midwest, *E. carunculata* Waterfall (sand-dune sandmat), likewise has non-mucilaginous seeds (Nathan Taylor, observation, 5 Feb 2015). *Euphorbia platysperma* and *E. carunculata* are strikingly similar in overall appearance. Both are glabrous and have long internodes, orange stems, seeds with a smooth dorsal surface, and similar appearing branching patterns, leaves, and cyathia. *Euphorbia carunculata*, *E. parryi* Engelmann, and presumably *E. platysperma* are part of a clade of several sand-adapted species in western North America (Yang & Berry 2011). However, *E. parryi* seeds produce moderate amounts of mucilage when wet (Susan Carnahan, observation, 10 Feb 2015).

Yuma Co. (west of TA): Sonora-Arizona border, 25 mi SE of San Luis at U.S. Border marker 198, *Felger 16707*. NW corner of Yuma Dunes, 7.4 km N of Mexico border, *Douglas 876* (ASU).

Euphorbia polycarpa Bentham

[*Chamaesyce polycarpa* (Bentham) Millspaugh. *Euphorbia polycarpa* var. *hirtella* Boissier. *E. intermixta* S. Watson. *E. polycarpa* var. *intermixta* (S. Watson) L.C. Wheeler]
Desert spurge; *golondrina*; vi'ibam. Figures 11E, 22.

Figure 22. *Euphorbia polycarpa*. (A) Roadside ditch, Hwy 86 between Why and Pisinimo, Pima Co., 23 Aug 2014. (B & E) Sand flats 22 mi S of Sonoyta on Mex Hwy 8, Sonora, 7 Sep 2014. (C) Wash crossing Hwy 85 at mile 66.5, 0.5 mi S of Alamo Wash, 3 Sep 2014. (D) Ajo, 25 Jul 2014.

Non-seasonal ephemerals, sometimes reproductive in a few weeks, to small perennials, the taproot well developed. Herbage and capsules glabrous or hairy. Stems prostrate to spreading or ascending, the larger plants much-branched. Leaf blades 1.5–6.8 mm long, broadly ovate or orbicular to oblong, the margins entire. Stipules narrowly triangular, ciliate; ventral side stipules fused basally, the dorsal side stipules separate. Involucral glands 0.3–0.6 mm wide, dark maroon (almost black) or sometimes yellow in summer, oval (wider than long), with conspicuous white appendages, or the appendages sometimes reduced or absent on drought-stressed plants. Stamens 15–32 per cyathium. Seeds 0.8–1.0 mm long, fairly smooth and grayish white, mucilaginous when wet.

This is the most common and widespread euphorbia in the region, ranging from the extremely arid southwestern side of the Tinajas Altas Mountains to the Ajo Mountains; washes, desert plains, bajadas, dunes, and rocky slopes. Sometimes these small plants grow from crevices, such as west-facing rock walls, spreading close to dark lava rock too hot to touch with bare hands in the summer. Seeds placed on damp paper germinated within 6 hours.

Arizona to southern Sonora, southern Nevada, and southern California to Baja California Sur.

Variation in *E. polycarpa* includes a continuum from glabrous or glabrate to densely pubescent herbage and capsules; glabrous or sparsely to densely pubescent plants sometimes occur freely intermixed, and glabrous or pubescent branches sometimes occur on the same plant. The pubescent plants have been called var. *hirtella,* but variation in pubescence shows no geographic segregation, and the type collection of *E. intermixta* appears to be nothing more than first-season plants of *E. polycarpa* (Steinmann & Felger 1997). Wheeler (1936) and Wiggins (1964) recognized several additional varieties, all from the Baja California Peninsula and its adjacent islands, and some of these may be worthy of continued recognition (Steinmann & Felger 1997). See *E. micromera* for comparison with *E. polycarpa.*

OP: Quitobaquito: 27 Nov 1939, *Harbison 26177*; Felger 90-95. Dripping Springs, 16 Apr 1952, *Parker 7934.* Alamo Canyon, 16 Feb 1979, *McLaughlin 1935.* 1 mi W of Hwy 85 on Puerto Blanco Drive, *Van Devender 31 Aug 1978.* E side of Sierra Santa Rosa, along border, 1635 ft, 12 Mar 2003, *Felger 03-357.*

CP: Pinacate Lava Fields, sandy soil, 20 Mar 1933, *Shreve 6214.* Pinta Sands, *Simmons 24 Nov 1962* (CAB). Agua Dulce Pass, *Simmons 19 Aug 1964* (CAB). O'Neill's Grave, 11 Apr 1992, *Harlan 185.* N side of Tule Mts, 2 Feb 1992, *Felger 92-59.* Heart Tank, 27 Feb 1993, *Felger 93-164.*

TA: Granitic hills, SW side of Tinajas Altas Mts, 10 Jan 2002, *Felger* (observation). Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-13.*

***Euphorbia prostrata** Aiton

[*Chamaesyce prostrata* (Aiton) Small] Figures 10, 23.

Small, warm-weather ephemerals (short-lived perennials elsewhere); often pubescent with short, crinkled, white hairs. Leaf blades 4.5–8.5 mm long, obovate-elliptic to oblong, usually with some hairs; margins serrated, usually minutely so and without magnification sometimes appearing entire. Stipules separate and slender, or united basally. Cyathia 0.4 mm wide; glands pink, transversely elliptic, 0.15 mm wide, without appendages or appendages minute and generally not as wide as the glands. Stamens 2–5 per cyathium. Capsules green, usually with white hairs especially on the angles (keels) and near the base. Seeds 0.7–0.8 mm long, ashy to tan, with a sharply-angled or ragged-edged crest and transverse ridges; not conspicuously mucilaginous when wet but adhering tenaciously after drying. (Description based largely on specimens from nearby northwestern Sonora.)

Usually near roadsides or other disturbed areas, mostly on sandy loam or gravelly wash beds; recorded in the northern part of Organ Pipe and likely more widespread in low areas.

Figure 23. *Euphorbia prostrata*. (A & D) Tucson, 28 Sep 2014. (B) By Lucretia Breazeale Hamilton. (C) N end of Bates Mts near Bates Well Road, 4 Aug 2014. (E) New Mexico State University Campus, Las Cruces, 26 Sep 2006, photo by Patrick Alexander.

Native from southeastern United States to South America; weedy and naturalized in many warm regions of the world.

OP: Armenta Ranch, *Wirt 20 Jul 1990* (ORPI). Cuerda de Leña within 1 mi of N boundary of Organ Pipe, 7 Oct 2006, *Rutman 20061007-13* (2 sheets, ARIZ 412364 & 412374).

Euphorbia setiloba Engelmann ex Torrey
[*Chamaesyce setiloba* (Engelmann ex Torrey) Millspaugh ex Parish]
Fringed spurge; *golondrina*. Figures 11F, 24.

Figure 24. *Euphorbia setiloba*. (A & B) Knucklehead Wash, base of Childs Mtn, 5 Sep 2014. (C) Alamo Wash near Hwy 85 bridge, 17 Sep 2014. (D) Cuerda de Leña near N boundary of Organ Pipe, 30 Sep 2006.

Non-seasonal ephemerals; densely glandular-pubescent including capsules. Herbage reddish in drier or cooler seasons, green to yellow-green in hot, humid seasons. Stems slender and wire-like, often reddish, with age often blackish and usually prostrate. Leaf blades 1–6.5 mm long, broadly ovate to elliptic or oblong, the margins entire; stipules minute conical "spurs" to 0.2 mm long and often not apparent (see *E. arizonica*). Cyathia 0.8–1.0 × 0.5–0.8 mm, urn-shaped (see *E. arizonica*), usually reddish; glands 0.2–0.3 mm wide, the appendages white, becoming pink with age, deeply divided into slender, pointed segments (the laciniate appendages are unique among Sonoran Desert euphorbias), the cyathium looking like a tiny star-shaped flower. Seeds 0.8–0.9 mm long, with a few low furrows or sometimes smooth; not conspicuously mucilaginous when wet but adhering tenaciously upon drying.

Often in broad, sandy-gravelly washes, canyon bottoms, and bajadas; widely scattered and common across the flora area, probably mostly at low elevations. The plants are frost-sensitive, and sometimes recover from light frost with new growth in the same season, or the plants perish with more severe freezing.

Southwestern United States to Baja California Sur and Sinaloa.

OP: Growler Canyon, 19 Mar 1975, *Lehto L18317* (ASU). Aguajita Wash, 13 Sep 1986, *Felger 86-276*. 0.8 km E of summit of Twin Peaks, 1 Aug 1990, *Baker 7885* (ASU). E of Armenta Ranch, *Rutman 30 Sep 2006*.

CP: Wash at N side of Tule Mts, 2 Feb 1992, *Felger 92-58*. Little Tule Well, 12 Jun 1992, *Felger 92-535*.

TA: Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-14*.

Euphorbia trachysperma Engelmann
[*Chamaesyce trachysperma* (Engelmann) Millspaugh]
Rough-seed spurge. Figures 11G, 25.

Summer ephemerals, glabrous, mostly 30–50 (90+) cm tall, usually taller than wide, the stems often relatively stout, the branches mostly ascending and straight. (Drought-stressed stunted plants only 2.5–5 cm tall can be reproductive.) Longer internodes 3.5–6 cm. Leaf blades often 3–5 cm long, linear to ovate-lanceolate, the margins minutely toothed (serrulate) at least near the tip. Stipules separate, ca. 1 mm long. Cyathia 1.5 mm wide, the glands green, round, 0.3–0.4 mm wide, the appendages pinkish, minute and inconspicuous although larger than the glands. Seeds 2.1–2.6 mm long, chunky and strongly 4-angled (quadrangular in cross section), gray to brown, granulated with a white waxy surface when fresh; copiously mucilaginous when wet.

Seasonally abundant in Cabeza Prieta in wet mud in Las Playas and at a dirt-tank waterhole. Also locally common in adjacent northwestern Sonora during the hot, humid, summer rainy season in playas and low-lying flats subject to temporary flooding.

Southern and central Arizona to northwestern Sinaloa, and Baja California Sur.

CP: Jose Juan Tank, locally common among mesquites near edge of charco, 14 Sep 1992, *Felger 92-723* (CAB). Las Playas, 28 Nov 2001, *Felger 01-568*. San Cristobal Wash, crossing Camino del Diablo/Bates Well Road, xeroriparian, 26 Sep 2013, *Rutman 20130926-6*.

Sonora: Mpio Benjamin Hill, 5 km S of Benjamin Hill on Mex 15, disturbed Sonoran desertscrub, uncommon, 27 Dec 2000, *Reina G. 2000-897* (plants 2.5–5 cm tall, with seeds).

Figure 25. *Euphorbia trachysperma*. Jose Juan Charco, 14 Sep 1992, *Felger 92-723* (ASU).

†Euphorbia spp.

OP: †Alamo Canyon, leaves, capsules, 1150 to 29,110 ybp (5 samples). Montezuma's Head, leaves, capsules, 13,500 to 21,840 ybp (3 samples). †Puerto Blanco Mts, capsules, seeds, modern to 9070 ybp (10 samples).

TA: †Tinajas Altas, capsules, 5940 to 11,040 ybp (4 samples).

Euphorbia section **Poinsettia**

Annuals to perennial herbs (in the flora area; also shrubs or small trees elsewhere). Cauline leaves alternate or sometimes opposite; without conspicuous stipules; sub-cyathial leaves (bracts) pseudo-whorled and often infused with white to red pigments. Glands cup-like or bilabiate, usually 1–3 per cyathium; appendages none. Seeds with or without a caruncle.

New World; about 20 species; the center of diversity is in Mexico where about 13 species occur. The two species in the flora area have C_3 photosynthesis (Webster et al. 1975).

1. Leaves opposite; seeds 2–3 mm long; petaloid appendages usually conspicuous, white or pink, and usually toothed ..... Subsection **Exstipulatae**: **Euphorbia exstipulata**
1. Leaves opposite below, alternate above; seeds 3–4 mm long; petaloid appendages not white or pink, not toothed, or absent.

2. Leaves linear, less than 3 mm wide; cyathia with 2 or more inconspicuous glands; capsules pubescent; seeds 3.5–4 mm long including a conspicuous caruncle. ..... Subsection **Erianthae**: **Euphorbia eriantha**
2. Leaves lanceolate to obovate, at least 10 mm wide; cyathia with a single, conspicuous cup-shaped gland; capsules glabrous; seeds 3–3.5 mm long, with an inconspicuous caruncle (or caruncle absent)..... Subsection **Stormieae**: **Euphorbia heterophylla**

Euphorbia section **Poinsettia** subsection **Eriantha**

This subsection has a single species.

Euphorbia eriantha Bentham
Beetle spurge. Figure 26.

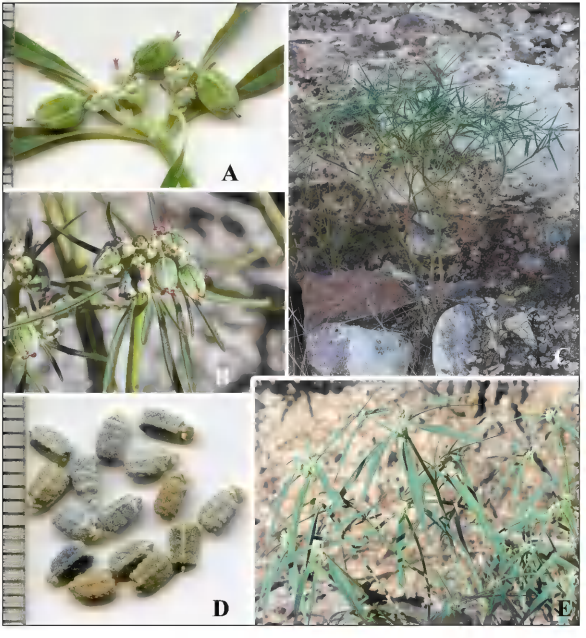

Figure 26. *Euphorbia eriantha*. (A) Daniels Arroyo, 24 Aug 2014. (B) Canyon at N end of Little Ajo Mts, 27 Mar 2005. (C) Wash crossing the northern Ajo Mountain Drive, Diablo Mts, 26 Aug 2014. Foothills E of Pinkley Peak, Puerto Blanco Mts: (D) 30 Sep 2014; (E) 12 Aug 2013.

Non-seasonal ephemerals/annuals, and sometimes surviving the winter as a "long-lived annual," although mostly seen as spring ephemerals. Plants often (15) 25–70 cm tall, the main axis usually erect with few to many branches above. Leaves linear, 2–6 cm long, less than 3 mm wide, the lower ones opposite, alternate above and usually quickly deciduous, the uppermost ones (bracts) in a whorl beneath the cyathia; stipules glandular and minute. Young herbage and inflorescences, including cyathia, ovaries, and capsules, densely pubescent with short, white, appressed hairs. Cyathia clustered at branch tips, noticeably longer than wide, involucres minute, with (2 or 3) 4 or 5 inconspicuous glands, these obscured by hairs and herbaceous, flap-like, feathery appendages arching upwards and inwards over the glands. Anthers and styles red, the styles not branched and protruding before the female pedicel elongates and before the male flowers (stamens) appear. Seeds 4-angled, mottled with white, gray, brown, or blackish markings, coarsely tuberculate, and with a minute cellular pattern, 3.5–4 mm long including a conspicuous whitish caruncle nearly as wide as the seed; mucilaginous when wet.

Widespread in the flora area; sandy soils including washes, bajadas, dunes, and sometimes on rocky slopes.

Baja California Sur to southeastern California and eastward to southwestern Texas, Coahuila, Durango, and lowlands of Sonora to northwestern Sinaloa.

OP: Bates Well, 5 Mar 1940, *Benson 9928*. Alamo Canyon, *McDougall 15 Mar 1941*. Dripping Well, Puerto Blanco Mts, 18 Mar 1945, *Gould 3018*. Aguajita Wash, 14 Sep 1988, *Felger 88-430*.

CP: 5 mi N of Tule Tank on road to Christmas Pass, 2 Feb 1992, *Felger 92-75*. Pinta Sands, 11 Apr 1993, *Felger 93-424*.

TA: Vicinity of Coyote Wash along Camino del Diablo, 20 Mar 1992, *Yeatts 3242* (CAB). Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-12*.

Euphorbia section **Poinsettia** subsection **Exstipulatae**

This subsection includes two species in southwestern North America to southern Mexico (Yang et al. 2012).

Euphorbia exstipulata Engelmann

[*Chamaesyce exstipulata* (Engelmann) Rydberg. *Euphorbia exstipulata* var. *lata* Warnock & M.C. Johnston] Figure 27.

Small annuals from a slender taproot, with opposite branching. Leaves opposite, 2–4 cm long, linear to lanceolate-elliptic (or ovate elsewhere); margins serrate. Cyathia in terminal clusters; involucral glands 4 or 5, oblong to circular, stalked (stipitate), laterally compressed and concave; involucral appendages white or pink, and toothed (also entire elsewhere). Ovaries and capsules glabrous or pubescent on and near the keels. Seeds broadly ovoid, quadrangular to rounded in cross-section, coarsely tuberculate with 2 transverse ridges and a minute caruncle.

Known in the flora area from at least one site at high elevation in the Ajo Mountains where it was locally common. The nearest known record is from the Sand Tank Mountains in the Sonoran Desert National Monument, and it also occurs near the summit of Table Top Mountain in the same national monument, and in the Baboquivari Mountains.

Widespread in Arizona above the desert and similarly in northeastern Sonora. Southwestern North America to southern Mexico. It was not included in the Euphorbiaceae of Sonora (Steinmann & Felger 1997) as the specimens have been collected since then.

Figure 27. *Euphorbia exstipulata*. (A–C) Saddle between Arch and Boulder canyons, 16 Oct 2003. (D) Sedona, Yavapai Co., 19 Aug 2004, photo by Max Licher (SEINet).

OP: Ajo Mts, dry saddle between Arch and Boulder canyons, 32°02.12'N, 112°42.4'W, 3600 ft, erect annual, 16 Oct 2003, *Rutman 20031016-18*.

Maricopa Co.: Sand Tank Mts, Sonoran Desert National Monument, N end of Arrowhead Mtn, steep N-facing slope, 3500 ft, erect annual with succulent leaves, with *Larrea*, *Canotia*, *Aloysia*, and *Viguiera*, 29 Nov 2003, *Rutman 20031129-12*.

Pinal Co.: Table Top Mtn., basin on summit of peak, 4100 ft, basalt substrate, 3 Sep 1981, *Butterwick 7895* (ASU).

Sonora: Mpio de Cananea, 23 km NE of Cananea on Mex Hwy 2, 1550 m, grassland, common annual on rocky road cut, 9 Sep 2002, *Reina G. 2002-587* (det. V.W. Steinmann, ARIZ, ASU, USON).

Euphorbia section **Poinsettia** subsection **Stormieae**

This clade includes 21 species of annuals to small trees, widespread in the New World and centered in Mexico. The Christmas poinsettia, *E. pulcherrima* Willdenow, native to Mexico, is included here.

Euphorbia heterophylla Linnaeus
[*Poinsettia heterophylla* (Linnaeus) Klotzsch & Garcke]
Mexican fire-plant, Mexican poinsettia, wild poinsettia. Figure 28.

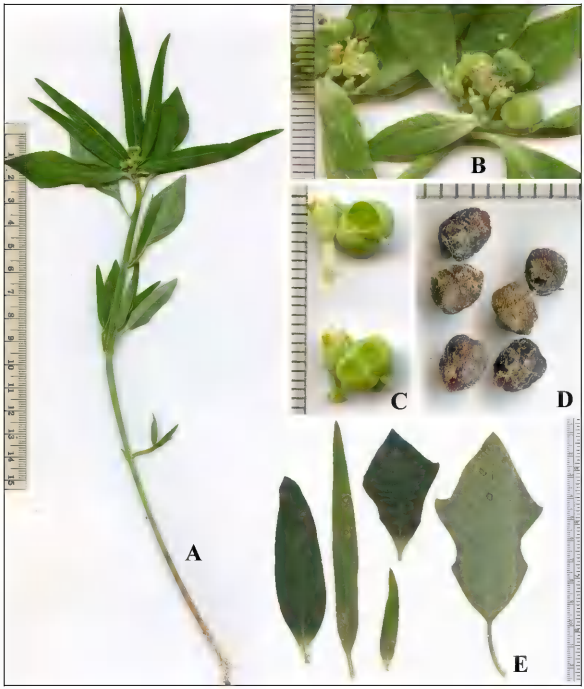

Figure 28. *Euphorbia heterophylla*. Roadside ditch, Hwy 86 between Why and Pisinimo, Pima Co.: (A) 8 Aug 2014; (B & C) 23 Aug 2014; (D) 11 Sep 2014; (E) 12 Sep 2008. Capsules partially flattened by scanner.

Warm-weather annuals; often robust with a single main axis and sparsely branched or not branched. Leaves opposite below, alternate above, and the uppermost ones (bracts) whorled below

the flower heads. Leaves highly variable, sometimes even on the same plant, 6–18 cm long, 0.8–5.5 cm wide, petioles short to long, the blades linear, lanceolate, elliptic, obovate, or obovate, the margins entire or coarsely lobed or toothed. Leaves below the cyathia may be white, pink, or reddish like a miniature poinsettia, although this coloration not seen on the few specimens from Organ Pipe and nearby areas. Cyathia with 1 gland, this cup-like with a circular opening and without a petaloid appendage. Ovary and capsules glabrous. Seeds 3–3.5 mm long, mottled, and with a flat caruncle (or caruncle may be absent); seeds not mucilaginous (e.g., *Helmkamp 7970*, Cochise Co., 2 Oct. 2002, UCR; Andrew Sanders, pers. comm. to Felger, 10 Feb 2015).

Canyons in the Ajo Mountains and occasional in washes near the northern boundary of Organ Pipe.

Also known from the Kofa Mountains and eastward in southern Arizona to Texas and Florida, and to South America. This attractive plant, often grown as an ornamental, has become naturalized and a serious agricultural weed in many warm regions worldwide. Although potentially toxic like other spurges, it is widely used medicinally, especially in parts of Africa.

OP: Bull Pasture, *Wirt 13 Aug 1990*. Kuakatch Wash, between Armenta Ranch and Cuerda de Leña, *Rutman 5 Oct 1995* (ORPI). Saddle between Arch and Boulder Canyons, ca. 3600 ft, 26 Oct 2003, *Rutman 20031026-40*.

Euphorbia subgenus **Esula**

Esula is a worldwide clade of about 480 species of diverse growth forms, although most diverse in north-temperate regions, especially in the Old World (Riina et al. 2013). Temperate region species, termed "leafy spurges" by Ricarda Riina, have C_3 photosynthesis. This subgenus is essentially absent from the Sonoran Desert except for the single population of *E. spathulata*, and *E. pephus* Linnaeus, a common, cool-season garden and farm weed in the Sonoran Desert region, native to the Mediterranean Region and now worldwide. These two species have relatively thin leaves and do not look like "desert plants." *E. spathulata* is in section *Helioscopia*, while *E. pephus* is in section *Tithymalus* (Riina et al. 2013).

Euphorbia spathulata Lamarck

Warty spurge. Figure 29.

Cool-season annuals, 10–35 cm tall; glabrous and bright green, stems mostly erect, solitary or branching from the base. Leaves 15–21 mm long, sessile, the blades obovate to broadly oblong, rounded or blunt at the tip, the margins serrated; alternate on stems except opposite or whorled below flowering branches and cyathia; stipules none. Cyathia including glands and flowers green to yellow-green; glands 4, without appendages. Ovary and capsule conspicuously tuberculate with warty glands. Seeds sub-globose, 1.5–2 mm wide, with a reticulate surface and a minute white caruncle; not mucilaginous when wet.

Common in wet mud of Las Playas following times of favorable rains, often among dwarfed mesquites. *Euphorbia spathulata* is not known elsewhere within the Sonoran Desert except a few records at the northeastern edge of the desert (see SEINet 2015). This leafy spurge is widely distributed in non-desert areas of Arizona as well as much of the United States and northern Mexico, and it also occurs in South America.

At Las Playas *E. spathulata* grows with other "playa plants" generally seen locally only after temporary flooding conditions: *Amaranthus crassipes, Chamaesaracha coronopus, Cyperus esculentus, C. squarrosus, Eragrostis pectinacea, Erigeron divergens, Eryngium nasturtiifolium, Euphorbia trachysperma, Hoffmannseggia glauca, Malvella sagittifolia, Marsilea vestita, Physalis*

lobata, Planodes virginicum, Sibara angelorum, Teucrium cubense, and *Veronica peregrina. Planodes virginicum* and *Sibara angelorum* (Brassicaceae) are disjunct from their general distribution, and *Planodes virginicum* is not known elsewhere within the Sonoran Desert (Felger et al. 2015). These plants form green carpets following the uncommon occasions when the otherwise barren playas become temporarily flooded. How did *E. spathulata* get there? Birds are unlikely vectors since the seeds are not mucilaginous. Human agency seems more likely, as this place was a crossroads for travelers and their horses, cattle drives, and early auto travel. "Pumpelly (1918) recounts being saved from thirst here by a summer thunderstorm, and Bryan (1925: 419) reminds us that 'all the ancient routes from Sonoita to Yuma came through las Playas because there was a good possibility of finding water there and because of the presence of horse feed'" (Broyles et al. 2007: 646).

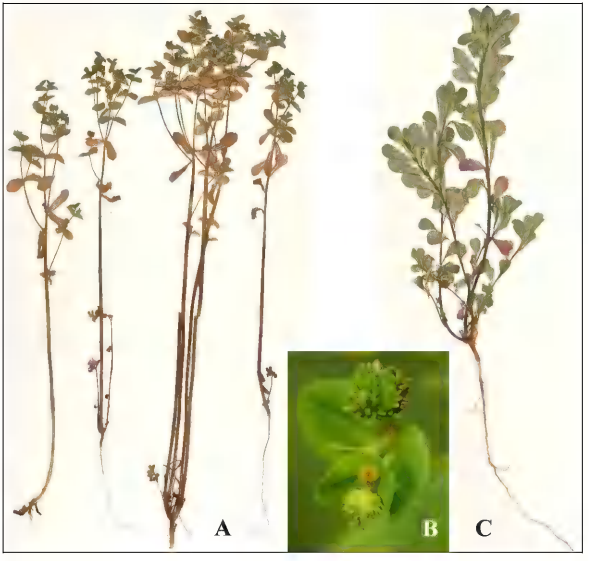

Figure 29. *Euphorbia spathulata.* Las Playas: (A) *Phelps 19 Mar 1978* (ASU); (C) 11 Jan 2002, *Felger 02-33.* (B) Sedona, Coconino Co., 11 Apr 2001, photo by Max Licher (SEINet).

CP. Las Playas: Common, *Phelps 19 Mar 1978* (ASU). S edge of Las Playas, 0.25 mi NE of Border Monument #180, "channels" still damp from previous standing water, with mesquite, 10 Apr 1978, *Lehto L-*

22467 (ASU). Clay surface of playa, juvenile, fairly numerous here, [with] *Marsilea*, 28 Nov 1997, *Harlan 478*. Channel banks, locally abundant, 1 Mar 1998, *Harlan 493* (ASU). Small plants, no flowers seen, some with reddish stems, common and widespread, 28 Nov 2001, *Felger 01-569*. Clayish soil with mesquite shrubs, 11 Jan 2002, *Felger 02-33* (ARIZ, ASU).

Jatropha

Multiple-stemmed shrubs with flexible stems in the flora area (herbaceous perennials to trees elsewhere). Leaves alternate or fascicled on short shoots, and drought-deciduous. Flowering with summer-fall rains, the fruits ripening in the same season. Stems and larger roots ooze blood-like sap when cut, hence the name *sangrengado* (dragon's blood). Male and female flowers on the same plant (those in the flora area). Fruit a capsule, those in the flora area 1- or 2-seeded by abortion of 1 or 2 carpels or ovules, or sometimes 3-lobed. Seeds with a caruncle.

Mostly tropical and subtropical, many in semi-arid regions and some in deserts, worldwide, mostly tropical Americas and many in Africa; 175 species.

1. Short-shoot leaves sessile or subsessile, the long-shoot leaves with petioles less than half as long as blades; leaves about twice as long as wide..... **Jatropha cuneata**
1. Petioles about as long as the blades; leaf blades about as broad as or broader than long.

2. Stems generally reddish; leaf blades shiny, and acute or pointed at tip... **Jatropha cardiophylla**
2. Stems generally grayish white or ashy; leaf blades dull, and blunt or rounded at tip ..... **Jatropha cinerea**

†**Jatropha cardiophylla** (Torrey) Müller Argoviensis
Heart-leaf limberbush; *sangrengado*. Figure 30.

Many-stemmed shrubs to ca. 1 m tall, often spreading clonally from thickened roots, with blood-red sap and reddish bark; glabrous. Foliage produced only during the brief summer rainy season, on long shoots and short, spur branches. Leaves mostly more than 2–3 cm long, prominently petioled, the blades broadly triangular, heart-shaped to ovate or rounded, rather thick, bright green and shiny; margins nearly entire to shallowly toothed, the teeth and margins with sessile glands. Inflorescences moderately branched, mostly several-flowered, as long as or longer than the leaves. Flowers white to pinkish, usually in July and August. Capsules mostly 1-seeded.

Widespread in Organ Pipe including the Ajo Mountains, but not in the southwestern part of the Monument (west of Quitobaquito). It has been in the mountains of Organ Pipe for at least 3500 years.

Southern Arizona to southwestern Sonora.

The flexible stems were sometimes used for basketry by the Tohono O'odham (Castetter & Underhill 1935). "The clear sap coagulates quickly and on contact with air and can be used for stanching the flow of blood from slight wounds" (Kearney & Peebles 1960: 509).

OP: Senita Basin, 1700 ft, 25 Jul 1978, *Bowers 1393*. Visitor Center, *Van Devender* 30 Aug 1978. Lost Cabin Mine Site, 2 Aug 1990, *Baker 7888* (ASU). Sierra Santa Rosa, 12 Mar 2003, *Felger* (observation). The Cones, trail above Bull Pasture, 3730 ft, 10 Apr 2005, *Felger* (observation). †Puerto Blanco Mts, on ridge, seeds, 3480 ybp.

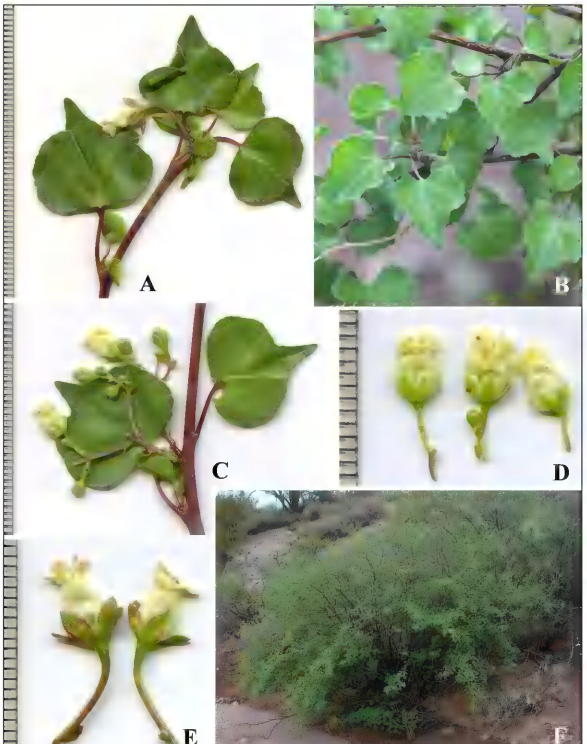

Figure 30. *Jatropha cardiophylla.* (A, C–F) Ajo Scenic Loop, Little Ajo Mts, 30 Jul 2014: (D) male flowers, (E) female flowers. (B) Sikort Chuapo Mts on Pipeline Road, NE of Ajo, 7 Sep 2012.

Jatropha cinerea (Ortega) Müller Argoviensis
Ashy limberbush; *sangrengado*; komagĭ va:s. Figure 31.

Multiple-stemmed shrubs often 1–2 m tall; stems rather thick and semi-succulent. Young herbage, inflorescence branches, calyces, and corolla buds moderately to densely pubescent with short white-woolly hairs. Leaves produced following rains during warm times of the year and quickly drought-deciduous. Long shoots produced with summer-fall rains and with leaves larger than short-shoot leaves. Long-shoot leaves on widely spaced nodes, the blades often shallowly 3-lobed, the lobes often with a few shallow teeth. Stipules apparently lacking (not found on specimens from

Arizona and Sonora, although some authors state stipules are present; Felger 2000). Short-shoot leaves with petioles 2.5–8 cm long, the blades 3–9 × 4–11.5 cm, more or less kidney-shaped, the upper surface greener and with sparser pubescence than the often densely pubescent, gray-green lower surface, the margins with few, small glands. Male flowers in compact, many-flowered clusters on slender inflorescence branches, the corollas pinkish-white or rose-colored, becoming white with age. Female flowers solitary, the sepals 4–6 mm long, linear to oblong, densely pubescent outside, glandular inside, the corollas dark pink inside. Fruits often 2-lobed and 2-seeded (1 carpel aborts), or sometimes 3-lobed; seeds round, 1 cm wide. Flowering in summer–early fall following rains, the fruits ripening in the same season, or sometimes flowering in spring.

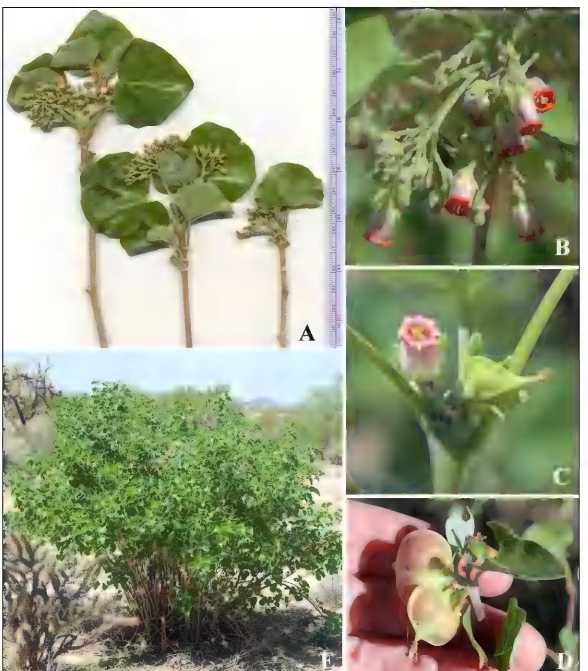

Figure 31. *Jatropha cinerea.* International boundary 3 mi W of Quitobaquito: (A) 26 Aug 2013; (B–E) 5 Sep 2013: (B) male flowers, (C) female flower and developing fruit, (D) young fruits.

Locally near the international border in the southwestern part of Organ Pipe, mostly along margins of small washes and on rocky hillsides. Not known elsewhere in the United States. The northern limit is undoubtedly determined by freezing weather (Turner et al. 1995); plants in the flora area are often freeze-damaged, sometimes freeze-killed to the ground and subsequently resprout (e.g., *Felger 88-465*). Widespread in northwestern Mexico.

Hia-Ced O'odham used the plant as a remedy for toothache and sores (Felger et al. 1992).

OP: Quitobaquito, *Nichol 28 Apr 1939*. Rancho Bonito, La Abra Valley, 5 Dec 1939, *Harbison 26207* (SD). 2 mi W of Quitobaquito, 1000 ft, sandy silty soil in valley, common, 29 Jul 1950, *Supernaugh 435*. Senita Basin, shrub to 3 ft tall, 25 Jul 1978, *Bowers 1392*. 0.9 mi W of Quitobaquito (old fields below pond) on border road, sandy flat, locally common, shrubs 95+ cm tall, all show signs of die-back to ground due to freezing, mostly along wash margins, often growing among shrubs, 14 Sep 1988, *Felger 88-465*. Road to Quitobaquito Springs, shrub 1.5 m tall, 2 m broad, along wash, 11 Oct 1988, *Baker 7637* (ASU, DES). S of Senita Basin, Lost Mine Road, shrub to 2 m tall, locally abundant, mostly along drainage, 12 Oct 1988, *Baker 7642-A* (ASU, DES). Lost Cabin Mine Site, granitic sand of wash, ca. 1.5 m tall, [&] as broad, fruit still green, 2–3-lobed, 2 Aug 1990, *Baker 7887* (ASU). 2.5 mi W of Hwy 85 on S Puerto Blanco Drive, 1500 ft, N-facing hillside, 11 Aug 1990, *Felger 90-405*. Hocker Well, 3 Dec 1990, *Felger* (observation).

†**Jatropha cuneata** Wiggins & Rollins
Desert limberbush; *sangrengado*; va:s. Figure 32.

Multiple-stemmed shrubs, often 1–2 m tall. Roots thick, somewhat tuberous. Stems thick and semi-succulent, beset with knobby short-shoots, often freeze-damaged during severe winters. Glabrous or glabrate, or young herbage with short white hairs. Short-shoot leaves appearing after rains at almost any time of year except during the coldest periods, and quickly drought-deciduous, 4–21 (41) × 2.3–9 (11) mm, sessile or short petioled, spatulate-cuneate, the margins entire except the apex often shallowly notched. Seedlings and long shoots growing with hot-weather rains; long-shoot leaves often 20–55 × 14–25 mm, usually 3 (5)-lobed or cleft, petioled, and quickly drought-deciduous. Stipules absent (or difficult to find?) or of minute, reddish, spur-shaped glands. Male flowers several in subsessile or short inflorescences, the corollas white. Female flowers solitary or in pairs, corollas white or pink, the fruiting sepals 3–6 mm long. Fruits round, 1-seeded, the seed round, 9–10 mm wide with a minute, white-waxy caruncle. Flowering mostly with summer rains.

Rocky hills and mountains, and sometimes on upper bajadas; widespread across the flora area. Frost-sensitive and not at higher elevations in the Ajo Mountains. The only prehistoric record is from 1250 years ago at Tinajas Altas.

Southwestern Arizona to northwestern Sinaloa, most of the Baja California Peninsula, and islands in the Gulf of California.

The flexible stems were widely used for basketry (e.g., Felger & Moser 1985; Lumholtz 1912: 331; Betty Melvin in Zepeda 1985: 61) and a reddish dye was made from the roots (Felger et al. 1992). The tender split stems were used in baskets for coiling around cattail stalks (*Typha*) or beargrass leaves (*Nolina microcarpa*) (Philip Salcido & Delores Lewis in Felger et al. 1992). Childs (1954: 36) reports red dye for women's buckskin dresses made from a "bush which we call Leather Weed—the Mexicans call it Sangre en Grande."

OP: W of Bates Well, Growler Valley, *Shreve 28 Mar 1932*. Quitobaquito, *Nichol 3 Mar 1939*. Dripping Springs, 16 Apr 1952, *Parker 7965*. Senita Basin, 25 Jul 1978, *Bowers 1394*. Sierra Santa Rosa, 12 Mar 2003, *Felger* (observation).

CP: 7 mi E of Papago Well, 22 Mar 1935, *Peebles 10862*. Sierra Pinta, *Arnold 14 Nov 1937*. Agua Dulce Mts, 18 Mar 1945, *Gould 3004*. Heart Tank, *Monson 27 Mar 1955* (CAB). Charlie Bell Well, *Johnson*

26 Mar 1960. Cabeza Prieta Peak, N-facing side of summit, 14 Mar 1995, *Yeatts 3652* (CAB).

TA: Tinajas Altas: "Juice clear, flowing freely. Much branched shrub attaining 6–7 ft. Dryer stained with a reddish mucilaginous sap from cut end of branch," 29 Mar 1930, *Harrison & Kearney 6567*; 12 Feb 1977, *Reeves R-5358* (ASU). Borrego Canyon, 3 Feb 1990, *Felger* (observation). †Tinajas Altas, 550 m, leaves, seeds, 1230 ybp.

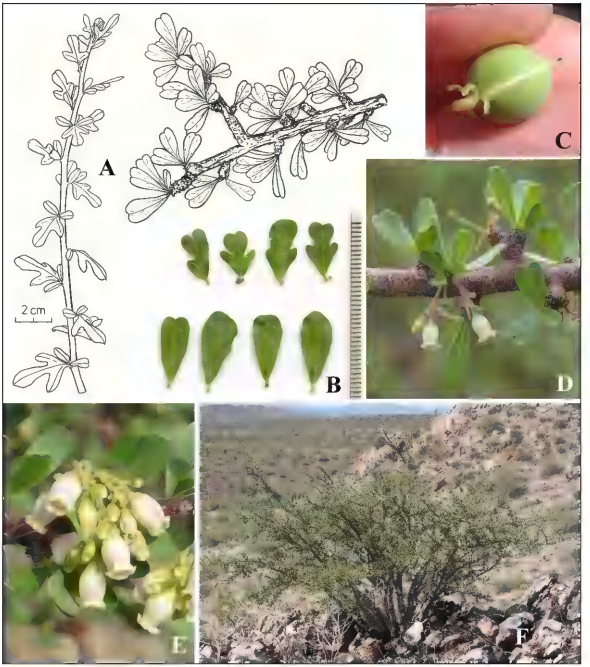

Figure 32. *Jatropha cuneata.* (A) Leaves on new shoot (left) and mature branch with spur branches (right), by Matthew B. Johnson. Ajo Scenic Loop Drive, Little Ajo Mts: (B) 28 Jul 2014; (D) female flowers, 1 Aug 2008. Little Ajo Mts near Ajo History Museum: 12 Sep 2008 (C) fruit, (E) cluster of male flowers; (F) 5 Sep 2011

Pleradenophora

Five species of trees and shrubs ranging from Arizona to South America (Melo et al. 2013). "Species of *Pleradenophora* were historically mostly classified within *Sebastiania*. Molecular phylogenetic analyses show *Sebastiania* in the broad sense is polyphyletic" (Wurdack in press).

†Pleradenophora bilocularis (S. Watson) Esser & A.L. Melo
[*Sebastiania bilocularis* S. Watson. *Sapium biloculare* (S. Watson) Pax]
Arizona jumping bean; *hierba de la flecha*; 'ina hita. Figure 33.

Multiple-stem shrubs 1.5–3 (4) × (1.5) 2–3 (4) m, with copious and toxic milky sap. Leaves alternate, glabrous and shiny green or often reddish with drought and cold weather, nearly evergreen to ultimately drought-deciduous, (2) 3–6 (11) × 0.5–2 (2.5+) cm, subsessile to short petioled, mostly lanceolate to elliptic, sometimes narrowly so; leaf margins with minute gland-tipped teeth and sometimes also with a few much larger, scattered, reddish-brown glands; also often with a pair of (or 1) rounded, yellowish to reddish glands 0.2–0.5 (0.9) mm wide at or near the base of the blade. Stipules to ca. 1.5 mm long, scale-like, reddish brown, and fringed. Inflorescences spike-like, 2–4.5 cm long, with 1 or 2 female flowers at the base (or female flowers sometimes not present), and male flowers above. Individual flowers small, sepals present, petals none. Female flowers with 2 prominent dark-purplish stigmas. Male flowers in clusters subtended by a short, succulent scale; each flower with 2 or 3 stamens and 2 short, thick glands; individual male flowers difficult to discern without careful dissection using magnification. Fruits of 2- (3)-seeded capsules. Seeds more or less rounded, ca. 6.5 mm wide, without a caruncle.

Washes, upper bajadas, canyons, hills, and mountains; widespread in Organ Pipe and the eastern part of Cabeza Prieta; not in the most arid, western ranges. The local distribution seems to be influenced primarily by freezing weather and soil moisture (Bowers 1980–81; Turner 1995). The largest known Arizona specimen (*Malusa 1 Jan 2001*) measured 13 ft in height, with a crown 18 ft wide (Arizona Registry of Big Trees 2005). It has been in mountains in Organ Pipe for at least 3500 years.

Southwestern Arizona southward to the Guaymas Region in Sonora, and both Baja California states.

The sap was famous as arrow poison and widely feared (e.g., Felger & Moser 1985). Chico Suni said it is "poison, it will kill you" (Felger et al. 1992: 27). Medicinal uses include treating sores (Nabhan et al. 1982). The seeds are a favorite food of packrats. This shrub is the host plant for a large native silk moth (*Eupackardia calleta*). The cocoons of this moth have been used by O'odham groups for Yaqui-style *pascola* leg rattles, and the O'odham name for the plant refers to a *pascola* dance step (Chico Suni in Felger et al. 1992). The seeds are sometimes parasitized by moth larvae (*Cydia deshaisiana*) and have been called "Mexican jumping beans." Sometimes sold as curios, these are more likely to be from *Sebastiania pavoniana*, a shrub or small tree in the Álamos region of southeastern Sonora.

OP: Quitobaquito: 30 Jan 1894, *Mearns 2753* (US); 6 Dec 1978, *Hodgson H-209* (DES). Canyon Diablo, 21 Mar 1935, *Peebles 10820*. Pitahaya Canyon, *Nichol 23 Feb 1939*. Alamo Canyon, 3000 ft, 14 Mar 1941, *Benson 10668*. Bates Well, *Tinkham 23 Apr 1942*. Organ Pipe, 2400 ft, S slope, larvae in seeds cause them to move, 23 Aug 1950, *Blakley B-559* (DES). Ajo Mts, small canyon immediately below the arch in Arch Canyon, 900 m, rare, shrub 1.5 m tall, 2 Dec 1990, *Felger 90-515*. †Alamo Canyon, leaf fragments, fruits, seeds, 1150 ybp. †Puerto Blanco Mts, on ridge, leaf fragments, seeds, modern to 3440 ybp (10 samples).

CP: Tule Wells, near Mexican border, small trees about 4 m tall, leaves red or green, 11 Jan 1975, *Booth A-132*. Agua Dulce Mts, Davidson Canyon at Mexican Boundary, 8 Apr 1979, *Lehto L23602* (ASU). O'Neill Hills, 17 Mar 1992, *Yeatts 3255* (CAB). Little Tule Well, 5 Mar 1994, *Felger 94-31*. Charlie Bell Road 3 km NE of Little Tule Well, 1282 ft, "multiple stems, ca. 2.6 m tall and 4 m across, the leaves unusually

large, the plant very leafy and green," 5 Mar 1994, *Felger 94-27* (ARIZ, ASU). Observations: Upper bajada, Sheep Mt, 31 Jan 1992, *Felger*; Eagle Tank, Heart Tank, *Felger*, 13 & 14 Jun 1992. Wash on bajada on SW side of Growler Mts, 1 Jan 2001, *Malusa*, observation (Arizona Registry of Big Trees 2005).

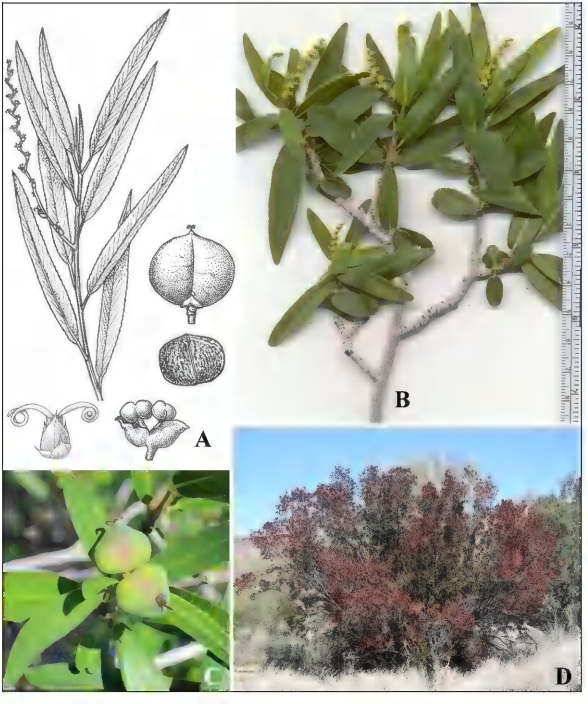

Figure 33. *Pleradenophora bilocularis*. (A) Female flower (left), male flower (right), by Lucretia Breazeale Hamilton. Ajo Scenic Drive, Little Ajo Mts: (B) 28 Jul 2014; (C) pair of fruits, 6 Sep 2013. (D) Winter foliage, Growler Valley near Bates Well Road, 29 Feb 2008.

Stillingia

Mostly herbaceous perennials, rarely annuals (also shrubs or small trees elsewhere). Mostly tropical and dry regions of the Americas, several in Oceania; 30 species.

Three species occur in the Sonoran Desert, two of them in Arizona. *Stillingia spinulosa* Torrey is found in southwestern Arizona, northwestern Sonora, southeastern California, and northeastern Baja California. It occurs near the flora area west of the Tinajas Altas Region and in adjacent northwestern Sonora. The Arizona species can be distinguished as follows:

1. Annuals or more often perennials; leaves alternate, linear, the margins entire or minutely toothed near tip. ..... **Stillingia linearifolia**
1. Spring ephemerals; leaves alternate below, opposite or whorled above, ovate, margins spinose-toothed. ..... **Stillingia spinulosa**

Stillingia linearifolia S. Watson

Queen's root. Figure 34.

Plants glabrous; 10–80 cm tall, annuals flowering in the first season as early as March or more often becoming perennial subshrubs, probably short-lived; quickly forming a deep taproot. Plants including herbage and inflorescences, flowers, and capsules green to bluish-green and/or reddish. Sap milky but thin and watery. Usually with many, mostly erect, slender stems arising from near the base; foliage usually sparse. Leaves alternate, linear, 1.5–5 (7) cm × (0.6) 0.9–2.8 mm, entire to minutely toothed at the tip; stipules 0.4 mm long, represented by stalked glands. Male and female flowers on the same plant. Flowers in slender, terminal or axillary, spike-like racemes 2–7 cm long, with female flowers at the base; flowers small, petals absent. Capsules 3-seeded, the seeds round, 2.6 mm wide. Growing and flowering any time of year with sufficient soil moisture, except during the coldest weeks or months.

Dunes and windblown sands in Cabeza Prieta in the vicinity of the Pinta Sands where the most extensive population occurs, and occasionally elsewhere in the Refuge in sandy soils. The plants sometimes show freeze damage. The one Organ Pipe record seems to be a waif; the locality has been revisited on a number of occasions but no other specimen has been found.

Western Arizona, southern California, southern Nevada, Baja California, northern Baja California Sur, and northwestern Sonora.

OP: Acuña Basin, headwaters of Aguajita Wash, 32°02′30″N, 112°55′W, just N of Puerto Blanco Mts, 19 Mar 1992, *Baker 8787A* (ORPI 14241).

CP: Pinacate Plateau: Open sandy desert, *Gentry 3515* (DES, annuals, reproductive); *Goodding 5 Mar 1940* (ASU). Pinta Sands: *Simmons 16 Mar 1963* (CAB); 780 ft, low dunes, pistillate flower reddish, subtended by red glands, the fruit green with red on carpel-ridges, the staminate flowers red,1 Feb 1992, *Felger 92-32*. 10.3 mi WSW of Papago Well, Camino del Diablo, 12 Mar 1983, *Daniel & Butterwick 2682* (ASU; annuals, reproductive). East Pinta Sands, 15 Sep 1992, *Felger 92-751*. 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002*.

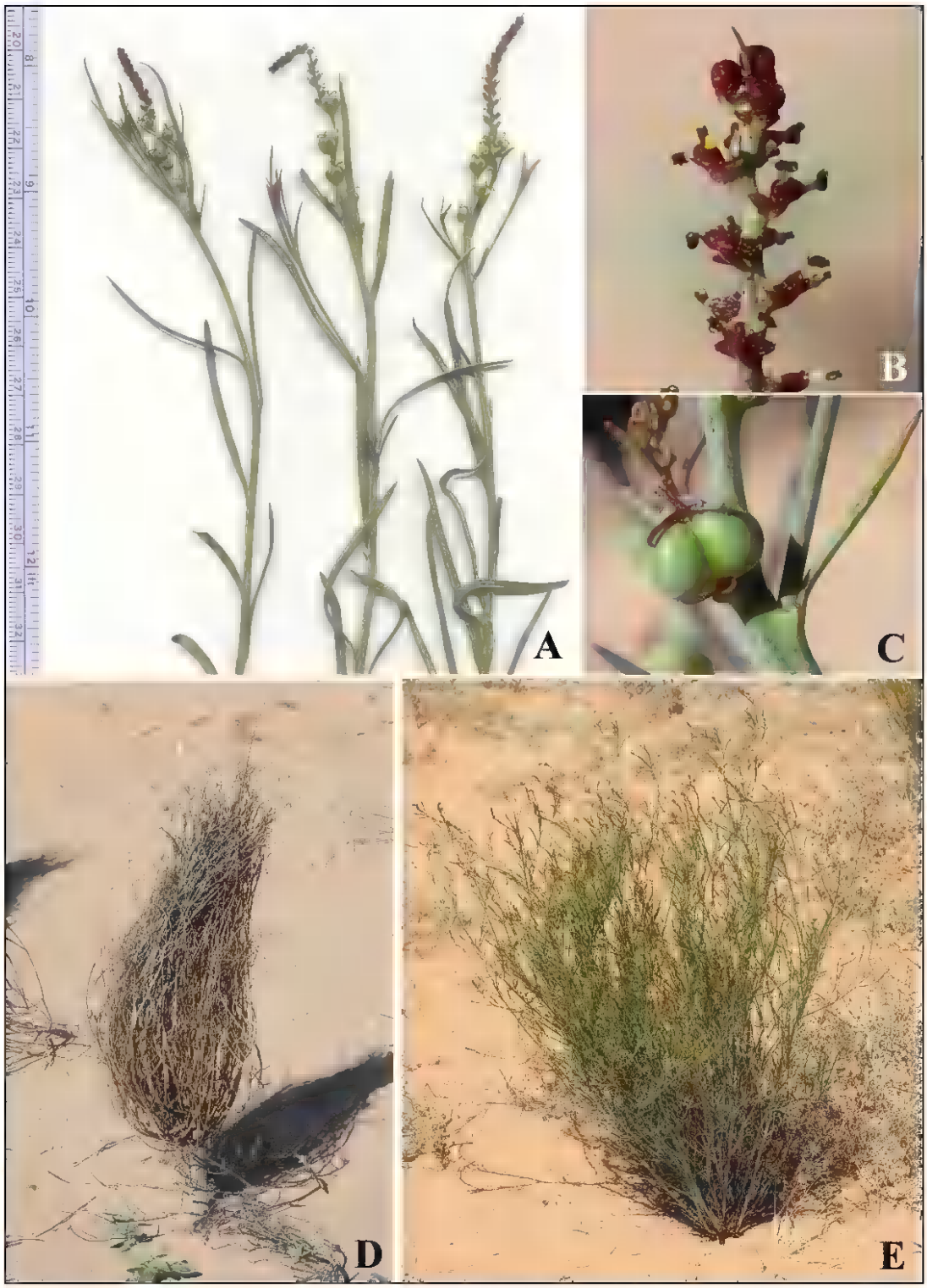

Figure 34. *Stillingia linearifolia.* (A) Pinta Sands, 11 Feb 2014. Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora: (B & C) 15 Feb 2014; (D) 17 Feb 2008. (E) Gran Desierto, Mex Hwy 2, 5 Mar 2014.

Tragia

Nearly worldwide, mostly tropical and subtropical; 175 species.

†**Tragia** sp.

Nose-burn; *ortiguilla*. Figures 35 & 36.

Herbaceous perennials, usually less than 50 cm tall, with stinging hairs; the hairs spreading, relatively long, slender, straight, and silvery; sap essentially absent. Plants green especially when well-watered and growing during hot weather, otherwise generally reddish-green especially in drought or dry seasons and winter. Stems slender and twining. Leaves gradually drought-deciduous, alternate, and petioled; blades often 1–3.5+ cm long, thin, broadly ovate to ovate, triangular-ovate, or lanceolate and mostly cordate at the base; margins coarsely toothed and ciliate with prominent stinging hairs; stipules triangular-lanceolate, green when young, becoming brown, scarious, and relatively persistent. Inflorescences of slender, terminal and axillary racemes 1.5–4.5 cm long including the peduncle: developing from young, growing stem tips, and continuing to develop as the stem elongates and thus appearing axillary (opposite from a leaf). Inflorescences with straight, spreading, silvery hairs throughout, finely glandular, the glands sessile, or some specimens with few sub-stipitate glands only at the inflorescence tips or throughout the inflorescence. Male and female flowers on the same inflorescences, petals none; female flowers solitary, at the base of inflorescences, the stigmas papillate; male flowers above, the pedicel bases persistent. Fruits of capsules, 3-lobed, the crests (midribs of the mericarps, or carpels) with prominent, spreading, silvery-white hairs like a miniature mohawk haircut. Seeds 3 per capsule, nearly globose, 2.5 mm wide; without a caruncle. Reproductive in response to spring and summer-fall rains.

Figure 35. *Tragia* sp. N-facing rocky slope, North Puerto Blanco Mountains, 5 Mar 2015.

Washes, canyons, and rocky slopes, often in shaded or protected habitats in many parts of Organ Pipe except the southwest corner. This or a similar species has been in the Puerto Blanco Mountains at least 3500 years.

Urtecho (1996; in press) reminds us that *Tragia* is a taxonomically difficult genus and that "The *Tragia* situation in SW AZ is complex" (pers. comm. to Felger, 3 Mar 2015). Indeed the

population in southwestern Arizona presents unanswered taxonomic questions and conflicting opinions, and we are in a quandary of what to call it. In our opinion, there is only one species of *Tragia* in Organ Pipe—perhaps it is an undescribed taxon or there is a need for modified interpretation of an existing or proposed taxon. Robert Urtecho (pers. comm. 2–4 Mar 2015) identified at least one Organ Pipe specimen as *T. jonesii* Radcliffe-Smith & Govaerts: The "image (*Pinkava 9978*, US) is of a plant that has both the stipitate glands and twinning habit of *T. jonesii*. This is what was once thought to be *T. amblyodonta*." However, George Ferguson found that the specimen of *Pinkava 9978* at ARIZ is not consistent with *N. jonesii* specimens from Sonora and lacks stipitate glands on the inflorescences. *Tragia jonesii* is distinguished in part by prominent tack-shaped (stipitate) glands at least on the inflorescences and occurs in western Sonora and the Baja California Peninsula. Steinmann and Felger (1997) reported the northernmost record to be from northwestern Sonora (6 mi E of Altar, *Wiggins 5972*, US). In another email, Robert Urtecho shared a "photo from Baja California (SD) of a plant that strongly resembles what you are observing. I call it *T. moranii*. It is not [stipitate] glandular . . . . Please see my dissertation for this description" and further reported, "I have looked over my records and can confirm that plants with leaves that match the size of '*T. moranii*' have been found with stipitate glands. The variability of *Tragia* is the cause of the confusion. Under shaded or moist conditions, leaves can double in size. There is also some variability in the glands present—even within the same population." *Tragia moranii*, however, has not been formerly published and is not known for certain north of Mexico. In his dissertation, Urtecho maps *T. moranii* in Baja California and Baja California Sur, and shows one locality in northwestern Sonora. The Organ Pipe specimens (cited below) show varying similarity with Urtecho's description for *T. moranii*.

Another possibility is aligning Organ Pipe specimens with a broadly interpreted *T. nepetifolia* Cavanilles, although Urtecho (pers. comm. to Felger, 5 Mar 2015) advises that the Organ Pipe specimens do not conform to his concept of *T. nepetifolia*. Urtecho (in press) indicates the United States and western Mexico populations of *T. nepetifolia* "most closely resemble var. *dissecta* Müller Argoviensis, one of four varieties." Urtecho also reports *Tragia nepetifolia* var. *dissecta* has papillate stigmas and "differs from other *Tragia* species in the flora area [United States] in its combination of leaf blades that are often red-tinged with dentate to serrate margins and proximally are broadly ovate to sometimes suborbiculate." He also reports *N. nepetifolia* in the U.S. to be a montane species of "pine-oak woodlands," and thus precluding Sonoran Desert occurrence. However, Steinmann and Felger (1997) report *T. nepetifolia* var. *dissecta* in Sonora occurring in Sonoran Desert, grassland, oak woodland, and pine-oak woodland. Who will follow Robert Urtecho's seminal work? Taxonomy can be intriguing.

OP: Alamo Canyon: 12 Apr 1944, *Clark 11589* (ORPI); 3 December 1977, *Bowers 985* (2 sheets, ARIZ 219423, 219365); *Van Devender 31 Aug 1978*. Puerto Blanco Mts, Dripping Wells, 18 Mar 1945, *Gould 3021*. Dripping Springs, 27 Oct 1951, *Supernaugh 455* (ORPI). Arch Canyon, along East Loop, 28 March 1965, *Niles 537*. 3.3 mi from Rt. 85, peaks encircled by East Loop, 24 Nov 1972, *Pinkava 9978* (ARIZ, ASU, DES, US). 1 mi E of Visitor Center on Ajo Loop Rd, 9 Sep 1984, *Van Devender 84-453*. Growler Canyon, *Wirt 24 Apr 1989* (ORPI). Below arch in Arch Canyon, 2 Dec 1990, *Felger 90-510*. W side and base of Sierra Santa Rosa, 509 m, 12 Mar 2003, *Felger 03-315*. Growler Valley, 8 Oct 2006, *Rutman 20061008-1*. †Puerto Blanco Mts, leaf fragments, capsules, seeds, 980 to 3440 ybp (3 samples).

Figure 36. *Tragia* sp. Alamo Canyon: (A & D) 10 Sep 2008; (E) 26 Mar 2005. (B) Arch Canyon, 16 Sep 2006. (C) Bates Well Road, about 1 mile S of Organ Pipe N boundary, 4 Aug 2014.

ACKNOWLEDGEMENTS

In addition to the acknowledgments provided in part three of this flora series (Felger et al. 2013b), we especially thank Paul E. Berry (MICH), George Ferguson (ARIZ), Walter Fertig (ASU), Richard (Rick) Alan Johnson (Silver City, NM), Geoffrey A. Levin (Univ. of Illinois at Urbana–Champaign), Andrew M. Salywon (DES), Andrew C. Sanders (UCR), and James (Jim) Thomas

Verrier (Desert Survivors Nursery, Tucson), and Robert Urtecho (College of the Sequoias, CA) for significant information and review. Walter Fertig (ASU), Tina Ayers (ASC), and Burrell E. Nelson (RM) provided specimen loans and/or images. Bill Broyles contributed geographic information and Susan Davis Carnahan provided expert copyediting and information.

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RANUNCULUS FICARIA (RANUNCULACEAE) NATURALIZED IN TEXAS: UPDATE

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ABSTRACT

In the 7 years since a report of its naturalization along a creek in Tarrant County, Texas, *Ranunculus ficaria* (now treated within the genus *Ficaria* as *F. verna*) has increased in number of plants and coverage at that locality. The Texas plants produce axillary bulbils and flowers apparently are sterile, producing only unexpanded achenes. Photos show population structure and characteristics of the habitat.

Ranunculus ficaria L. was earlier observed (Nesom 2008) to be naturalized along Overton Creek within Overton Park in Fort Worth, Texas. It was noted that "Thirty discrete plants, clearly naturalized, grow in an area of about 30 square feet ... . A second population of five scattered plants occurs on the stream terrace about 300 yards downstream." In 2015, areal coverage of plants of *Ranunculus ficaria* has increased by about 6 times; the original larger population has expanded, additional colonies have formed downstream between 20 and 50 yards from the original, and an additional large population has arisen downstream of plants seen in 2008, increasing the linear extent of the total population to about 400 yards. Photos of subgroups of the Overton Park population (Figs. 1–7) show the characteristic habitat and dispersion of the plants — all are growing in wet soil immediately beside the water or close by on the low, frequently flooded terrace.

Phylogenetic studies indicate that *Ranunculus ficaria* is best treated within the Eurasian/northern African genus *Ficaria* Guett. (comprising ca. 5 species) rather than within *Ranunculus* (Paun et al. 2005; Emadzade et al. 2010), this alternate taxaonomy already adopted by Weakley (2012). The genera *Myosurus* L. and *Ceratocephala* Moench as a pair are sister to strictly defined *Ranunuculus*. *Ficaria* and its sister genus *Coptidium* (Prantl) Beurl. ex Rydb. are sister to the *Ranunculus*/*Myosurus* clade. *Ranunuculus ficaria* L. is *Ficaria verna* Hudson; typical *Ficaria verna* is equivalent to *Ranunculus ficaria* subsp. *bulbifera*.

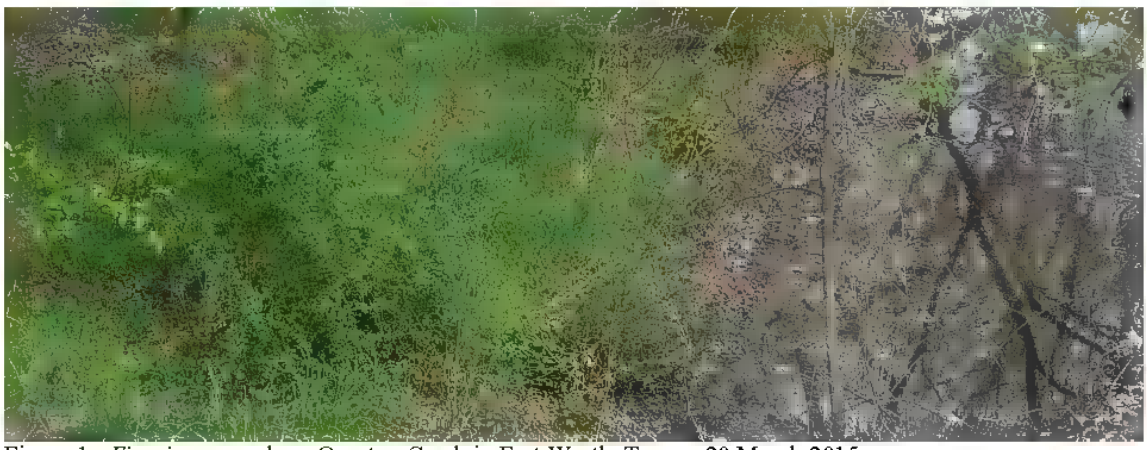

Figure 1. *Ficaria verna* along Overton Creek in Fort Worth, Texas. 20 March 2015.

Figures 2 and 3. *Ficaria verna* along Overton Creek in Fort Worth, Texas. 20 March 2015.

Figures 4 and 5. *Ficaria verna* along Overton Creek in Fort Worth, Texas. 20 March 2015.

Figures 6 and 7. *Ficaria verna* along Overton Creek in Fort Worth, Texas. 20 March 2015.

Ficaria verna in the USA sometimes forms dense monocultures (see numerous internet photos) and has been found to limit germination of other species by allelopathy (Cippolini & Schradin 2011; Cipollini & Flint 2013). The species is becoming invasive in the eastern and northeastern USA and adjacent Canada (Krings et al. 2005; Post et al. 2009; Axtell et al. 2010) and also is naturalized in the Southeast (Alabama – Davenport 2011; South Carolina – Marlow et al. 2014, Marlow 2015) and in north-central Texas.

Sell (1994) distinguished five subspecies within *Ficaria verna* (as *Ranunculus ficaria*) based primarily on leaf and flower size, achene fertility, and whether or not axillary bulbils are produced after flowering. His key has been reproduced frequently in reference to North American populations (e.g., Krings et al. 2005; Post et al. 2009; Axtell et al. 2010; Weakley 2012). Post et al. conducted a morphometric study of North American plants, finding evidence to support recognition of the 5 infrataxa recognized in Europe and evidence that all of them are naturalizing in the USA.

Figure 8. Broadly cylindric-ellipsoid axillary bulbils of *Ficaria verna*, Overton Creek population, 27 April 2015. Bulbils are 4–9 mm long.

The Overton Creek plants were characterized in 2008 this way: "The leaves are numerous and densely crowded at the base on short stems. Most [leaf blades] are ca. 6–7 cm long and 5–5.5 cm wide, ranging smaller to 3 x 3 cm, on petioles 8–10 cm long. The flowers are ca. 2.5–4 cm in diameter with 7–9 petals 15–19 mm long, 6–8 mm wide. Pollen (2 plants) is ca 70% viable, as

judged by uniform size and full-staining in lactophenol-cotton blue; the remaining 30% of the grains are non-staining and distinctly smaller (and highly variable in size). All achenes apparently are glabrous and infertile. Axillary bulbils were not present at the time of collection (8 March) but were in abundant production by 2 April — they are whitish, conic-cylindric to short-cylindric, and essentially without surface features." These measurements are consistent with plants observed in 2015. Broadly cylindric-ellipsoid axillary bulbils, 4–9 mm long, are shown in Figure 8 from plants photographed 27 April 2015 — these are representative of the whole Overton Creek population. On 27 April, all peduncles had almost completely withered, although the leaves were still green.

The Overton Creek plants were orginally identified (Nesom 2008) as *Ranunculus ficaria* subsp. *bulbifera*, as they produce axillary bulbils and unexpanded, infertile achenes and the vegetative dimensions best matched those of subsp. *bulbifera* in published keys. According to Sell, subsp. *bulbifera* is the only entity with infertile ("poorly developed") achenes. Subsp. *bulbifera* and subsp. *ficariiformis* are the only two that produce axillary bulbils (both entities also are polyploid; the others are diploid). Post et al. (2009) and Axtell et al. (2010), without comment, identified the Texas plants as subsp. *ficariiformis*, perhaps weighting the diagnostic value of bulbil shape, noted by Sell to be "globular, rounded-obtuse" in subsp. *bulbifera*, "ovoid or globular" in subsp. *ficariiformis*. Bulbil shape, however, is not included as as diagnostic feature in the key to subspecies by Sell or those who have adopted and republished his key.

Ficaria verna has recently been documented in Greenville and York counties, South Carolina (Marlow et al. 2014 and Marlow 2015, including many color photos). Plants from Lake Conestee Nature Park in Greenville County are identified by Marlow et al. and Marlow (2015), citing the key from Weakley (2012), as *Ficaria verna* subsp. *verna* (= subsp. *bulbifera*) — implying that achenes are infertile (this is not specified in their published observations but photos in Marlow 2015 show expanded, apparently fertile achenes: jkm130415_346, jkm130415_350); bulbils are globose to subglobose: e.g., jkm130612_230). A different population from Greenville Co. (along an urban creek) and another from York Co. (along an urban creek in Rock Hill) are identified in Marlow (2015) as *Ficaria verna* subsp. *ficariiformis*; these plants produce a range of bulbil shapes, from globose or subglobose to broadly cylindric-ellipsoid to distinctly club-shaped: e.g., jkm140124_584.

The Alabama voucher (Davenport 2011; see image at Alabama Plant Atlas Editorial Committee 2015) cannot be identified to infraspecific level — it is a young plant perhaps collected prior to bulbil formation, without fruits, and only 2 leaves are represented.

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Floden, A. 2015. A new beebalm, *Monarda austroappalachiana* (Lamiaceae), from the Southern Appalachians. Phytoneuron 2015-28: 1–9. Published 29 April 2015. ISSN 2153 733X

A NEW BEEBALM, *MONARDA AUSTROAPPALACHIANA* (LAMIACEAE), FROM THE SOUTHERN APPALACHIANS

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ABSTRACT

A new species of *Monarda* subg. *Monarda*, **Monarda austroappalachiana** Floden, **sp. nov.**, endemic to the Southern Appalachians, is described and illustrated. Its distribution is limited to calcareous phyllite and limestone in the Southern Unaka Mountains and Southern Cumberland Plateau, respectively. Its morphology is compared to that of *M. clinopodia*, the species with which it has been confused, and to *M. fistulosa*, its hypothesized sister species. Taxonomic significance of morphological characters of the *M. fistulosa* group (defined here) — such as a hispidulous style, fibrous stems, and hirsute calyx orifice — are discussed.

Specimens of a post-anthesis *Monarda* L. were collected by the author the first week of June, 2008, from phyllite talus of the Walden Creek formation in the Ocoee River Gorge in Polk Co., Tennessee. The plants are short with 4-5 internodes per flowering stem and glabrous except for some nodal stipular bands of retrorse trichomes and a few retrorse trichomes on the angles of the internode subtending the inflorescence. Examination of specimens at TENN showed that plants of this morphology have mostly been identified as *M. clinopodia* L., but compared to the latter, they are nearly glabrous, flower earlier where sympatric, are thicker-leaved, and have larger, emaculate, white corollas with the upper corolla lobe apex with pilose trichomes. The clinopodia-like plants are described here as the novel species *M. austroappalachiana*, based on examination of specimens at TENN and MO, personal cultivation of most taxa discussed, fieldwork over the 2008-2013 seasons in Arkansas, Texas, Missouri, and Tennessee, and data presented here. The new species has been collected from glade-like habitats and talus slopes and roadsides predominantly from the Ocoee River Gorge in the Southern Appalachians and in the Southern Cumberland Plateau of Tennessee and Georgia.

Monarda austroappalachiana is more similar to *M. fistulosa* than *M. clinopodia* in morphology and habitat. Both species produce hairs at the apex of the upper corolla lobe, a hirsute calyx orifice, firm-textured leaves, ligneous stems (in contrast to the fleshy stems of *M. clinopodia* and *M. didyma*), and hispidulous styles (Table 1).

Monarda consists of about 18 species native to North America including Mexico. These are divided into two subgenera supported by molecular analyses (Prather et al. 2002): subg. *Monarda* with 11 species and subg. *Cheilyctis* with 7 species. Subg. *Monarda* occurs in eastern North America and Mexico with one species, *M. fistulosa*, extending westward to the Rocky Mountains. There are two distinct morphological groups in subg. *Monarda*: the *M. didyma* group and the *M. fistulosa* groups are distinguished by leaf shape, indument of the leaves and stems, inflorescence characters, and corolla sizes (McClintock & Epling 1942; Scora 1967; Turner 1994). The *M. fistulosa*-group is united by the presence of hispidulous styles, densely hirsute calyx orifices, and pilose to comose upper-corolla lobe apices (Table 2). In this group I include the following species: *M. austroappalachiana, M. fistulosa* var. *fistulosa*, *M. fistulosa* var. *brevis*, *M. lindheimeri*, *M. luteola*, and *M. stipitatoglandulosa*. Of these *M. austroappalachiana* is presumably more closely related to the latter four members of the group (all of the group except typical *M. fistulosa*) and an unnamed

taxon from Kentucky (J. Campbell, pers. comm.) — see Discussion below for characters shared between the new species and the *M. fistulosa* group. All of these taxa usually begin flowering before sympatric *M. fistulosa* (Waterfall 1970; Kimball et al. 2001; Singhurst & Holmes 2011).

MONARDA AUSTROAPPALACHIANA Floden, **sp. nov.** **TYPE: USA. Tennessee**. Polk Co.: US 64/Hwy 30, ca. 1 mi N of Hwy 64, on slope on W side of road, 16 May 2012, *A. Floden 2128* (holotype: TENN; isotypes: MI, MICH, US, MO, BRIT, NCU, GA, UTC, TENN). Figures 1–3.

Differs from *M. clinopodia* L. in its shorter stems 30–50 cm tall, firm-textured leaves, hirsute calyx orifice, stipitate-pilate-glandular calyx tube, calyx lobes with stout dark-colored stipitate glands, larger corolla 25–30 mm that is white and emaculate, the upper corolla lobe 12–14 mm vs. 5–8 mm, and in its distinctly earlier blooming period where the two species are sympatric. It differs from the more similar *M. fistulosa* L. in the reduced density of trichomes of the comose upper corolla lobe apex, white vs. pink corolla, leaves glabrous on both surfaces and dark green vs. gray, stems glabrous except at the nodes, and earlier flowering.

Plants perennial, erect. **Rhizomes** short, internodes 2–5 cm, 4-angled, purple to green, ca. 3 mm diameter. **Stems** 4-angled, 30–50 cm, purple below, green above, minute retrorse to spreading trichomes at internodes, lowermost (2–3) internodes finely puberulent, glabrous above, rarely some retrorse trichomes present on internode below the inflorescence, 1–3 branched. **Leaves** simple, opposite, petiolate; **petioles** 0.5–1.5 cm, 1–2 mm wide, glabrous; **blades**, proximal stem leaves ovate-elliptic, distally lanceolate, 2.5–7 × 1.5–2 cm, lamina glabrous, dark green adaxially, paler grey-green abaxially, punctate, strongly *Oregano*/thymol-scented, margins ciliate, 8–11 pairs per stem, internode 1.5–7 cm, shorter below, elongate above, nodes with few spreading trichomes, ca. 1 mm long. **Inflorescences** terminal, 1(–3) per stem, subtended by 6–8 large bracts; **glomerules** 1.5--2 cm wide excluding corollas, subtended by foliaceous bracts, lowermost glandular punctate, ovate-lanceolate to lanceolate, the largest 5 × 2 cm, and 5–10 smaller lanceolate to linear bracts, 1.5–3 × 0.5–1.5 cm successively reduced in size, grayish, occasionally pink-tinted, with green margins, strongly ciliate with smaller bracts with cilia to 1mm, larger with cilia to 0.5 mm, surfaces glabrous, 40—90-flowered. **Calyx** 8–12 mm, tubular, strongly 13 nerved, stipitate glandular on nerves, trichomes ca. 0.5 mm, with interspersed eglandular trichomes, calyx lobes, ca. 0.75–1.25 mm, with 2–5 stipitate-pustulate, anthocyanic (dark-based) glands, calyx orifice with introrse trichomes, 0.5–1 mm, margins often strongly purple colored. **Corolla** white to creamy, emaculate, 25–35 mm, stipitate glandular with longer spreading pubescence, upper lip 12–14 mm, apex with 5–15 uniseriate trichomes 1–3 mm long, lower lip 6–9 mm, 3-lobed, center lobe 2–4 mm, margins parallel, apex bifid. **Anthers** purple, segments 1.5–2 mm, ovate, pollen yellow; **filaments** glabrous, exserted 4–6 mm beyond upper corolla lip. **Style** hispidulous proximally to near middle, apex bifid, exserted 4–8 mm beyond the upper corolla-lobe apex, reddish-purple at apex. **Nutlets** 1–1.5 mm, light to dark brown.

Common name. Southern Appalachian beebalm.

Etymology. Named for the area to which it is endemic, the Southern Appalachians, a region of high endemism in eastern North America.

Phenology. Flowering middle to late May into early June, fruiting July to September.

Distribution and ecology. *Monarda austroappalachiana* is endemic to limited area of northern Georgia, southwest North Carolina (no specimens cited), southeast Tennessee. This species grows in talus slopes, open woodland, road edges, and steep rocky slopes in sub-xeric habitats with reduced competition from other forbs or woody plants. It most frequently grows in the Walden Creek geologic formation, a calcareous phyllite. No specimens are cited from North Carolina, but photographs of plants *in situ* and one cultivated accession from Macon County southwest of Franklin (D. Probst, pers. comm.) confirm its presence there.

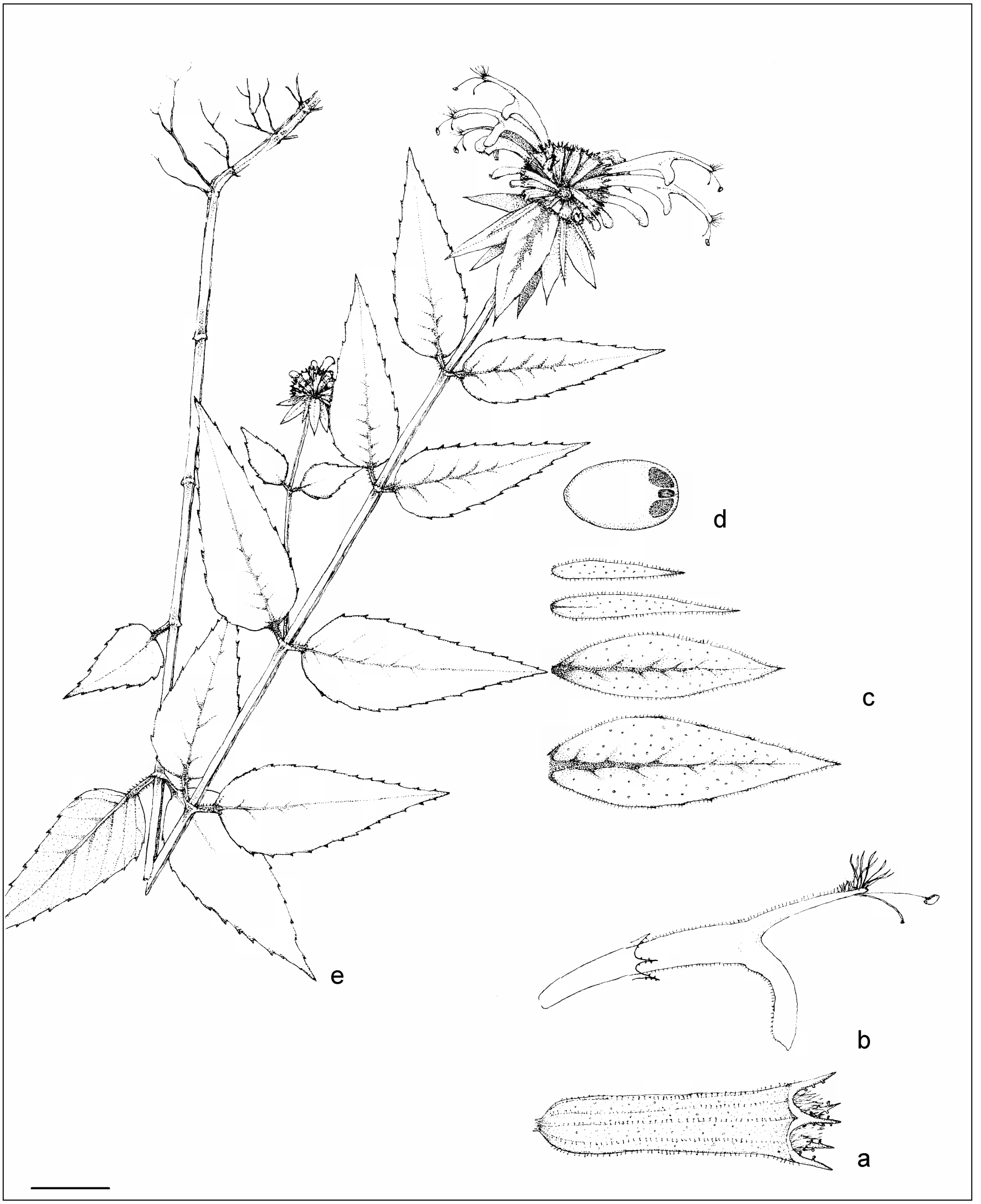

Figure 1. *Monarda austroappalachiana*, drawn from *Floden 912* (TENN). A. Calyx. B. Calyx and corolla. C. Glomerule bracts. D. Nutlet/mericarp. E. Whole plant. Scale bar: a = 2 mm; b = 0.7 cm; c = 1 cm; d = 1 mm; e = 2 cm.

Figure 2. *Monarda austroappalachiana* in its naural habitat, Ocoee River Gorge, Polk County, Tennessee. Photo by the author

Figure 3. Calyces of *Monarda austroappalachiana* showing the short stipitate glands on the tube, the reddish stout glands on the calyx lobes, and the hirsute calyx orifice. Calyces ca. 1 cm long.

Additional specimens examined. **Georgia**. Walker Co.: cultivated accession from Pigeon Mt., *Campbell s.n.* (TENN). **Tennessee**. Hamilton Co.: N. Chickamauga Creek, common along trail and parking lot at Bowater Pocket Wilderness parking lot, 25 May 1995, *Pyne 95-083* with Bowen (VDB, TENN). Marion Co.: along roadside of Raccoon Mt. Rd ¼ mi beyond Pumped Storage Reservoir toward Massengill Rd, N 35 03.743, W 085 22.999, 1319 ft., 24 May 2011, *Blyveis 641* (UTC, TENN); W-facing slope, upslope from Kellys Ferry/Mullins Cove Road near Tenn. River-mile 445.7, Wauhachia Quadrangle, oak-pine forest with fairly open canopy (burned in 2007), 35.0707,-85.3949 (NAD-83), 30 May 2008, *McCoy & Bishop s.n.* (TENN). Polk Co.: Hwy 64 W of Goforth Creek and E of Caney Creek, 21 Jul 2011, *Floden & Hart 1660* (TENN); along Hiwassee River just before Hwy 68 crosses the river, near NC border, 11 Aug 2011, *Floden 1696* (TENN); Powerhouse Rd along Hiawasee River, at parking area before Cappy Branch growing on limestone shelves on roadside, post anthesis!, 15 Jun 2011, *Floden 1602* (TENN); forest area at Spring Creek N of Hiwassee, 2 Jun 1971, *Somers Jr., Bowers, Smith, & Skorepa 46085* (TENN); Hwy 40 near dam #2 on N side of rd, 18 Jun 2008, *Floden 562* (TENN); Hwy 30, ca. 1.2 mi W of Reliance along shaley slope on roadside, 5 Jun 2009, *Floden 903* (TENN); Hwy 40/74 E of Parksville on wooded roadside above Lake Ocoee, 5 Jun 2009, *Floden 905* (TENN); Hwy 40/74, near a small waterfall on N side of road, 5 Jun 2009, *Floden 909* (TENN); Hwy 40/74 ca. 2 mi before dam #2, shaley slope with abundant plants on roadside, 5 Jun 2009, *Floden 912* (TENN); Hwy 40/74 before dam #2, 5 Jun 2009, *Floden 918* (TENN); Hwy 40/74 before dam #3, 5 Jun 2009, *Floden 919* (TENN); roadside along US Rte 64 near the margin of Lake Ocoee, corollas cream colored with a blush tinge, 10 May 1959, *Carter & Houk 25777* (TENN); along roadside (Rte 64) on the banks of Lake Ocoee, cream flowers with a blush tinge, 10 May 1959, *Carter & Houk 25776* (TENN); roadside along Hwy 64, ca. 5 mi E of Parksville along the Ocoee River between Greasy Creek and Madden Creek, 9 May 1977, *Wofford, Webb, & Evans 77-59* (TENN); along Ocoee Lake on moist shaded slope, white flowers, 8 Jun 1958, *Sharp, Norris, & Russel 23616* (TENN); mesic, open roadside, Rte 30, ca. 1 mi N of Rte 64, 4 Jun 1989, *McNeilus 89-332* (TENN); bluff of Lake Ocoee above Parksville, white flowers, 21 April 1961, *Sharp & Pringle 28456* (TENN); roadside, road from Parksville to Ducktown, ca. 11 mi from Parksville, 7 Jun 1940, *Shaver 7882* (TENN); Hwy 30, ca. 1 mi N of Hwy 64, on slope on W side of road, 16 May 2012, *Floden 2128* (TENN); Spring Creek Road, N of Hiwassee River, along Spring Creek, substrate largely Walden Creek Shale, 5 Jun 2012, *Floden 2156* (TENN) and *Floden 2159* (TENN); Ellis Rd, FS44, near creek, 7 Jun 2012, *Floden 2188* (TENN); Oswald Dome Rd, shalely slope with spring-fed ditch at base, highly shaded N-facing slope, 7 Jun 2012, *Floden 2192* (TENN); Baker Creek Rd, S of Ocoee River on FS 302 just past Baker Creek on small shaley slope, 18 Aug 2012, *Floden 2208* (TENN). Van Buren Co.: Fall Creek Falls State Park, 3.0 km N of junction of Hwys 285 and 30, growing on limestone bench above two waterfalls, ca. 1 km E of Old Cane Creek Church, Bald Knob Quad, 365 m, 23 May 2002, *Fleming, Smith, Bowman FCF-2084* (TENN).

The following specimens from Tennessee are cited because of their proximity to or disjunction from populations of *Monarda austroappalachiana*, and they also serve to show ranges in flowering times.

Monarda clinopodia. Polk Co.: Hiwassee River at bridge below Farner, Hwy 68, 15 Jul 1969, *Rogers & Bowers 43926* (TENN); rocky mesic woods along Big Creek, elev. 550 m, corolla white, 12 Jul 1983, *Murrell 368* (TENN); Hwy 30 near Taylors Island parking area on N side of road, 5 Jun 2012, *Floden 2153* (TENN) and 7 Jun 2012, *Floden 2177* (TENN); Powerhouse Rd along Hiawasee River, at parking area before Cappy Branch, moist woodland and river floodplain, 15 Jun 2011, *Floden 1601* (TENN).

Monarda austroappalachiana and *M. clinopodia* only occur within close proximity at two sites in Polk Co., Tennessee. Observations over four field seasons shows that their flowering periods rarely

coincide with the last flowers of the former in anthesis as the first of the latter begin. They also occupy different habitats — *M. austroappalachiana* on subxeric, open sites and *M. clinopodia* in mesic, heavily shaded woodland.

Monarda fistulosa. Bradley Co.: Moist roadside NE of Cleveland, near McMinn Co. line, purple flowers, 15 Jun 1948, *Fairchild, Clebsch, Sharp 48-11* (TENN); near Cleveland, 26 May 1934, *Sharp & Hesler 1103* (TENN). McMinn Co.: Hwy 39, just before 310, on shaley slopes on NE side of road, 7 Jun 2012, *Floden 2166* (TENN). Monroe Co.: Roadside bank on Tenn. Hwy 72, 8 Oct 1961, *Sharp, Pringle, Drumke, Ellis, Ramsey 29668* (TENN); road from Tellico Plains to Farmer, near Polk Co. line, in moist soil by stream in mountains, 30 Jun 1935, *Wilson 3791* (TENN). Polk Co.: Hwy 315, ca. 1 mi N of Spring Creek Rd, on Tellico Drainage, not within the Hiwassee Drainage, 7 Jun 2012, *Floden 2191* (TENN).

Monarda fistulosa is not syntopic with Tennessee populations of *M. austroappalachiana* in the Ocoee River Gorge or along the Hiwassee River. All populations of *M. fistulosa* observed in Polk County occur within the Tellico River drainage approximately 20 kilometers north of the closest *M. austroappalachiana* populations. The next closest population of *M. fistulosa* occurs west of the Ocoee River Gorge in Bradley Co., Tennessee.

Discussion

Monarda austroappalachiana is described based on morphological study of nearly all species of *Monarda* subg. *Monarda*. Subg. *Monarda* contains two morphologically distinct groups, each defined by several shared characters (e.g., calyx orifice hirsute vs. not, pubescence on the upper corolla lip, depth of stamen attachment) (Scora 1966) with two anomalous species, *M. bradburiana* and *M. russeliana*. The *M. fistulosa* group is united by several morphologies: the presence of a hispidulous style from the middle to the proximal portion, a densely hirsute calyx orifice, comose to pilose upper corolla apices, and dark-colored, fibrous, hard stems. The *M. didyma* group has glabrous styles throughout, non-comose corolla lobe apices, and usually distinctly fleshy green stems.

A direct comparison of *Monarda austroappalachiana* to *M. fistulosa* shows that it differs in the merely pilose upper corolla lobe apex, rather than comose apex of the corolla. Furthermore the density of calyx orifice trichomes is reduced. The leaves of the new species are glabrous and dark green whereas those of *M. fistulosa* and *M. stipitatoglandulosa* are short gray-canescent with a distinctly grayish appearance. In *M. austroappalachiana* the stem is glabrous, but the other species are usually canescent with short curled trichomes, pubescent with sparse, long trichomes on the stem angles, or densely pilose mixed with shorter curled trichomes. In *M. austroappalachiana* trichomes on the stems are restricted to the internode subtending the inflorescence and a thin stipular line of hispid trichomes at each node. The stem indument in *M. fistulosa* is densely short and canescent or intermixed with longer spreading trichomes (rarely glabrous on the faces). *Monarda stipitatoglandulosa* has densely pilose stems and *M. fistulosa* var. *brevis* has glabrous stem faces but long spreading trichomes on the angles (Fig. 1). The leaves of *M. austroappalachiana* are similar to *M. fistulosa* var. *brevis*, but that species is lustrous rather than matte in appearance (Fig. 2). It is also distinct from *M. clinopodia*, which has membranous, hispid-pubescent leaves, a smaller, maculate corolla (Table 1), and mesic habitats. Moreover the blooming period of *M. austroappalachiana* is complete or nearly so before both sympatric species begin to flower.

The taxonomic history of the *Monarda fistulosa* group and its subdivision into species or varieties has varied by author: none recognized by McClintock and Epling (1942); 5 varieties by Scora (1967) and by Fosberg and Artz (1953); and 2 by Turner (1994). Nonetheless, many of the species are easily diagnosed by their morphology and generally geographically restricted though often sympatric with *M. fistulosa*. Despite their sympatry with *M. fistulosa*, they often flower before it,

Table 1. Comparative table of morphology of *Monarda austroappalachiana*, *M. fistulosa*, *M. clinopodia*, and *M. stipitatoglandulosa*. All measurements in centimeters unless noted.

Species	***austroappalachiana***	***clinopodia***	***fistulosa***	***stipitatoglandulosa***
Rhizome				
internode	pachymorphic	leptomorphic	variable	pachymorphic
Stem				
height	20--50	40--100	40--130	20--50
color	purple	greenish	green-purple	green-purple
vestiture	mostly glabrous, nodes pubescent	glabrate to long pubescent	pubescent	pubescent
Foliage				
petiole	0.5-2.0	1.5-2	0.5-1.5	0.5-1.5
petiole indum.	glabrous	pubescent	pubescent	pubescent
base	cuneate, to rounded	truncate rounded	sub-cordate, rounded	rounded
apex	long acuminate	acuminate	acuminate	acuminate
vestiture	glabrous	pubescent	canescent	pubescent
texture	subcoriaceous	membranous	herbaceous	herbaceous
Bract number	6--8	6+	6--10	6--12
length	1.5--5	0.5--1.5	1.5--3	1--2.5
width	0.5--2	0.2--1	1--2	0.5--1
color	white with pink	pale green-white	silvery	silvery
vestiture	minutely canescent	lamina canescent veins pubescent	canescent veins pubescent	canescent
Perianth				
calyx	0.9--1.2	0.6--1	0.8--1	0.7--0.8
teeth	1-1.5 mm	1 mm	1-1.2 mm	1-2 mm
vestiture	stipitate glandular on veins	canescent, stipitate glands interspersed	canescent	densely stipitate glandular
corolla	2.5--3.5	1.5--2.5	2.4--3.0	2.0--3.0
color	white	white, red spotted	lavender-purple	white to cream (sometimes pink)
vestiture	stipitate glandular, long pubescent	short pubescent	short pubescent	stipitate glandular
upper lip	1.2--1.4, apex pilose	0.5--0.8 (0.8--1), apex glabrous	1--1.2, apex comose	0.9--1.3, apex comose
lower lip	3-lobed, middle lobe margins parallel, apex bifid	3-lobed, middle lobe acuminate, apex erose to bifid	3-lobed, middle lobe margins parallel, apex bifid	3-lobed, middle lobe margins parallel, apex bifid
style	hispidulous	glabrous	hispidulous	hispidulous
Flowering	late April-early June	mid-June—July	late June, July into August	late May-June

Table 2. Indument characters of the style and calyces of the species of *Monarda* subg. *Monarda* recorded from herbarium specimens (sample size n=20+, *n=<10) and supplemented from literature. *Monarda clinopodia* is listed three times because each form is morphologically distinct; two of them representing corolla-size forms (see McClintock & Epling 1942) and the other representing a non-maculate corolla form (J. Campbell personal communication).

Species	**style**	**calyx vestiture**	**calyx lobes**
austroappalachiana Floden	hispidulous	glandular-pubescent	glandular-pubescent
bradburiana Beck	glabrous	puberulent	glandular-pubescent
clinopodia L. (greenish-spotted)	glabrous	glandular-pubescent	glandular-pubescent
clinopodia (unspotted)	glabrous sparse	glandular-pubescent	glandular-pubescent
clinopodia (reddish-spotted)	glabrous	pubescent	glandular-pubescent
didyma L.	glabrous	glandular-pubescent, eglandular	glandular-pubescent, glabrous
fistulosa L.	hispidulous	canescent	glandular-pubescent
**lindheimeri* Engelm. & A.Gray	hispidulous	hispid-pubescent, hirsute	glandular-pubescent
**luteola* Singhurst & Holmes	hispidulous	glandular-pubescent	glandular-pubescent
**malloryi* Gilly	glabrous	puberulent	short-glandular-pubescent
media L.	glabrous	pubescent, glandular	glandular-pubescent
menthifolia Graham	hispidulous	dense pubescent	sessile-glandular
russeliana Nutt. ex Sims	glabrous	glandular-pubescent, pubescent	pustulate-glandular
sp. nov. KY	hispidulous	glandular-pubescent, pubescent	glandular-pubescent
stipitatoglandulosa Waterfall	hispidulous	glandular-pubescent	glandular-pubescent

with only occasional overlap. Species of this early-flowering group are united by their white to creamy corollas and stout stipitate calyx lobe glands (Fig. 3). *Monarda stipitatoglandulosa* has distinctly pilose stems and is mostly found in the Ouachita Mountains of Oklahoma and Arkansas (Waterfall 1971). The recently described *M. luteola* (Singhurst & Holmes 2011) and *M. lindheimeri* are morphologically similar to one another but allopatric in distribution. Another unique variant for which Kimball et al. (2001) provided distinctive molecular evidence is the limestone barren endemic *M. fistulosa* var. *brevis* of the Ridge and Valley of Virginia and West Virginia. This taxon is strongly distinct from *M. fistulosa* and should be recognized at species rank. Similarly, a morphologically

distinct plant undetermined to species occurs on the Knobs of Kentucky and is undoubtedly related to *M. fistulosa* var. *brevis*.

ACKNOWLEDGEMENTS

I thank the Dennis Breedlove Fund for monetary assistance that enabled much of the fieldwork, A. Prather and J. Campbell for discussion on *Monarda*, financial support from R041011035 from URS Corp. Inc. and the Tennessee Department of Transportation (awarded to J. Shaw and D. Estes for "Botanical Investigation of Corridor K Alternative Corridors, Ocoee Tennessee"), and J. Solomon and the staff at MO for access to the collections.

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KEY TO NATIVE AND CULTIVATED SPECIES OF *ERYTHRINA* (FABACEAE) IN THE USA AND COMMENTS ON NATURALIZATION OF *E. CRISTA-GALLI*

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ABSTRACT

An identification key and brief comments are provided for species of *Erythrina* that are native in the USA — *E. flabelliformis* and *E. herbacea* — as well as non-native ones often cultivated — *E.* x *bidwillii*, *E. caffra*, *E. coralloides*, *E. crista-galli*, *E. falcata*, *E. humeana*, *E. latissima*, *E. lysistemon*, *E. speciosa*, *E.* x *sykesii*, and *E. variegata*. Collections and most reports of *E. crista-galli* in the USA indicate that it is best regarded either as merely persistent in cultivation or else a non-perpetuating waif. There is no evidence that any other species of *Erythrina* is naturalized in the USA.

Erythrina L. comprises 110–130 species (estimates by Krukoff & Barneby 1974 -108; Krukoff 1982 -108; Bruneau 1996 -112; Mackinder 1993 -130; Mackinder et al. 2001 -110; Bean 2008 -120), which are native to the southern USA through Mexico and Central America into South America, southern Africa, and southeast Asia. Molecular studies (Bruneau & Doyle 1993; Bruneau 1996, 1997) have confirmed previous hypotheses of the morphological coherence of the genus and support its monophyly.

Two clearly distinguished species of *Erythrina* are native to the continental USA (Isely 1998): *E. flabelliformis* and *E. herbacea*. Other species are cultivated, particularly in California and Florida, for their brilliant red to scarlet flowers. McClintock (1982) included 37 taxa in her account of those cultivated in California (Table 1). Her earlier key to cultivated *Erythrina* in the USA (McClintock 1953) included 16 taxa (those not included here: *E. acanthocarpa*, *E. americana*, *E. arborescens*, *E. macrophylla*, and *E. zeyheri*,). Good introductions to the commonly cultivated species and many color photos are available on the internet (e.g., Stein 2009; PlantZAfrica.com 2015). Some of these may persist outside of cultivation in the USA but only one, *E. crista-galli*, has been noted or reported (at least as implied) to be naturalized in the USA.

Table 1. *Erythrina* species cultivated in California (McClintock 1982)

E. abyssinica Lam.
E. acanthocarpa E. Meyer
E. americana Miller
E. arborescens Roxb.
E. atitlanensis Krukoff & Barneby
E. barqueroana Krukoff & Barneby
E. x bidwillii Lindley
E. brucei Schweinf.
E. caffra Thunb.
E. chiapasana Krukoff
E. corallodendrum L.
E. coralloides DC.
E. crista-galli L.
E. falcata Benth.
E. flabelliformis Kearney
E. goldmanii Standley
E. guatemalensis Krukoff
E. herbacea L.
E. humeana Spreng.
E. lysistemon Hutch.
E. macrophylla DC.
E. mexicana Krukoff
E. mitis Jacq.
E. peoppigiana (Walp.) O.F. Cook
E. rubrinervia H.B.K.
E. speciosa Andrews
E. standleyana Krukoff
E. steyermarkii Krukoff & Barneby
E. x sykesii Barneby & Krukoff
E. tahitensis Nadeaud
E. tajumulcensis Krukoff & Barneby
E. variegata L.
E. vespertilio Benth.
E. zeyheri Harvey

A key and comments are provided here for *Erythrina* species commonly encountered in the USA, making this information easily available and accompanying a treatment of the native species for the Flora of North America North of Mexico (Nesom submitted). Whether *E. crista-galli* is naturalized in the USA also is considered.

KEY TO NATIVE AND COMMONLY CULTIVATED SPECIES OF *ERYTHRINA* IN THE USA

1. Corollas banners pseudotubular, enclosing keel and wings (pollinated mostly by hummingbirds); species of North America and South America.

2. Perennial herbs or (in southernmost localities) shrubs, 1–2.5(–5) m; leaflet blades ovate-acuminate to hastate-ovate, subtrilobed; native to s and e USA ..... **Erythrina herbacea**
2. Trees or shrubs, 2–8 m; leaflet blades broadly ovate to depressed-ovate, not lobed; native to Arizona and New Mexico, southward into Mexico, or (*E. speciosa*) South America.

3. Terminal leaflets (12–)15–22 cm long; corollas red or pink; calyx tube 10–15 mm long ..... **Erythrina speciosa**
3. Terminal leaflets (3–)5–8.5(11.5) cm long; corollas red; calyx tube 6–8 mm long.

4. Trees 3–5 m; keel petals longer than wings, sagittately auriculate at base, apex dorsally apiculate with projections less than 2 mm long; rachis, pedicels, and calyx tomentellous with reddish to brownish hairs; native to e Mexico, cultivated in the USA .. **Erythrina coralloides**
4. Multi-stemmed shrubs or trees 1.5–5(–9) m; keel petals shorter than or barely equalling wings, not sagittately auriculate at base, apex dorsally caudate with projections 2–5 mm long; rachis, pedicels, and calyx softly short-strigose to tomentellous with pale gray hairs; native to Arizona and New Mexico and southward in western Mexico to Jalisco and Baja California Sur ..... **Erythrina flabelliformis**

1. Corolla banners folded to convex and boat-shaped, usually distinctly separated from keel and wings (pollinated mostly by perching birds, sometimes also by bees); species of South America and Asia, cultivated in the USA.

4. Central leaflet at least as broad as long, broadly ovate to suborbicular, densely tomentose when young, gradually glabrescent at least beneath and becoming coriaceous; calyx spathelike, lobes linear-lanceolate and long-attenuate, 6–8 mm long ..... **Erythrina latissima**
4. Leaflets usually longer than broad, mostly ovate to elliptic, glabrous, usually not coriaceous; calyx campanulate, 2-lipped, or spathelike, teeth or lobes (if present) linear, 1–3 mm long.

5. Multi-stemmed shrubs 1.2–1.5 m tall; flowering with leaves in late summer to fall and early winter; calyx campanulate, apex truncate with short, linear, abruptly emerging teeth ..... **Erythrina humeana**
5. Trees (3–)5–30 m tall, single-stemmed from the base; flowering without leaves spring to early summer; calyx various.

6. Calyces glabrous or glabrate, deeply campanulate with apex entire, weakly 2-lipped if at all; inflorescence of flowers relatively loose along axis; seeds dark brown without red.

7. Inflorescence pendulous, 15–30 cm long, terminal or lateral, with densely-flowered racemes often in groups of 2 or more toward ends of branches, leafless; corollas usually never fully opening (banner covers the stamens and other petals until displaced by a visiting bird); leaflets not reticulately waxy beneath; mature fruits nearly flat, 20–30 mm wide, margins nearly straight ..... **Erythrina falcata**

7. Inflorescence arching, 50–70 cm long, terminal, leafy, or flowers axillary, racemes loosely-flowered; corollas fully opening; leaflets minutely reticulately waxy beneath; mature fruits irregularly cylindric, 12–15 mm wide, shallowly constricted between seeds.

8. Banner 1.5 times longer than wide, not spreading and only slightly reflexed; stamens enclosed by keels except for exserted anthers ..... **Erythrina crista-galli**
8. Banner 2.5 times longer than wide, spreading and reflexed from other parts; stamens enclosed in lower half by keels, upper half-exserted . **Erythrina** × **bidwillii 'Camdeni'**

6. Calyces densely hairy, prominently spathelike (deeply split on 1 side) or 2-lipped; inflorescence of densely clustered flowers; seeds red to purple or reddish brown.

9. Calyces spathelike, margins with linear lobes 2–3 mm long, floccose-puberulent with stellate hairs; leaf rachises with stellate hairs, glabrescent; mature fruits nearly flat, 15–20(–30) mm wide, very shallowly constricted between seeds, surface prominently coarsely raised-reticulate; mature bark smooth (prickly when young) ..... **Erythrina variegata**
9. Calyces distinctly 2-lipped, lip margins entire, densely and closely villous-puberulent with simple hairs; leaf rachises glabrous; mature fruits (none in *E.* × *sykesii*) 10–15 mm wide, deeply constricted between seeds, surface not at all reticulate; mature bark distinctly furrowed or corky.

10. Flowers sterile, mature fruits not formed; keels separate, ca. 1/2 the length of the banner ..... **Erythrina** × **sykesii**
10. Flowers fertile; keels fused along lower margin, ca. 1/4–1/3 the length of the banner.

11. Corollas scarlet; banner 2.4–6.8 cm long, 1.2–2.9 cm wide (longer, narrower), relatively straight and folding to enclose the other petals and stamens; flowers declined toward the inflorescence axis ..... **Erythrina lysistemon**
11. Corollas orange-scarlet; banner 3.8–5.4 cm long, 1.5–3.4 cm wide (shorter, broader), curving upward away from other corolla parts and exposing the stamens; flowers spreading away from the inflorescence axis ..... **Erythrina caffra**

Erythrina × **bidwillii** Lindl. **'Camdeni'** (shrub coral tree, Bidwill's hybrid coral bean, fireman's cap)

Sterile hybrid between *E. crista-galli* and *E. herbacea*. Spreading shrubs or small trees 2–4 meters tall, floering while leafy, deciduous. The original hybrid was made in Australia in about 1840 — distinct forms were segregated from the progeny (Wikipedia 2013). *Erythrina* × *bidwillii* 'Camdeni' (the common one in the USA) is similar to *E. crista-galli* in its perennial woody form, while *E.* × *bidwillii* 'Blakei' follows *E. herbacea* in dying back to a rootstock each year. Increased frost tolerance in the hybrid reflects its heritage from *E. herbacea*, and in Austin, Texas, *E.* × *bidwillii* is said to recover to flowering more quickly than *E. crista-galli* after a frost (San Marcos Growers 2015).

Erythrina caffra Thunb. (coastal coral tree, cream coast coral tree, Kaffir coral tree)

Deciduous to semi-deciduous (leaf drop and flowering sometimes occur at the same time) trees 8–12(–21) meters tall. Native to Mozambique and coastal regions of South Africa, cultivated widely, and reported to be naturalized in India, Australia, and New Zealand. It is the official tree of Los Angeles, California.

Erythrina coralloides DC. (flame coral tree, naked coral tree)

Deciduous, low-spreading trees mostly 3–5 m tall. Native to eastern Mexico (Guanajuato, Hidalgo, México, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Tamaulipas, Veracruz). See Krukoff and Barneby (1974) and McVaugh (1983) for comments on variation within the species.

Erythrina crista-galli L. (crybaby tree, cockspur coral tree, fireman's cap tree)

Deciduous, broadly spreading trees 5–8(–10+) meters tall, called "crybaby tree" because of abundant nectar that sometimes drips from the flowers. Native to South America (Argentina, Brazil, Paraguay, Uruguay) and the national flower of Argentina, Peru, and Uruguay. Widely cultivated in tropical and subtropical regions, naturalized in New Zealand and coastal districts of eastern Australia (Bean 2008).

In Australia, *Erythrina crista-galli* is abundantly naturalized along waterways, in swamps and wetlands, and in urban bushland (Queensland Govt. 2015) — it reproduces by seed and also by branches and stem fragments carried by water and rooting. In Puerto Rico, Liogier (1988, p. 161) noted that it is "occasionally planted and escaped"; Liogier and Martorell (2000, p. 81) noted that it is "occasionally planted and naturalized." It has been planted as a street or garden tree in California since at least 1853 (San Marcos Growers 2015) and also is cultivated in Florida and along the Gulf Coast of the southeastern USA westward to south Texas.

Erythrina crista-galli is one of the hardiest of the coral trees — once established, it tolerates temperatures to 20° F without significant dieback and is root hardy down to 14° F (San Marcos Growers 2015). The combination of cold tolerance, fast growth, and flowering even in young individuals apparently underlie its popularity and wide geographical range of cultivation in the USA.

In a study of the reproductive biology of *Erythrina crista-galli* in Argentina and Uruguay (Galetto et al. 2000), only 6% of flowers set seed in natural populations but almost 93% of recorded flowers were visited by carpenter bees and honeybees, with the rest visited by four species of hummingbirds. The species is self-compatible but seed set and germination are higher in outcrossed flowers.

Erythrina crista-galli naturalized in the USA?

Indications or implications that *Erythrina crista-galli* is naturalized in the southeastern USA (Kartesz 2014; USDA, NRCS 2015 — in Florida, Georgia, Louisiana, and Mississippi) have been picked up and repeated in other literature (e.g., Randall 2012; Queensland Govt. 2015). Various statements (and implications) about the USA plants, however, have been less than explicit.

Weakley (2012, p. 500, citing Isely 1990, 1998 and Kartesz 1999) has noted this regarding *Erythrina crista-galli* as a member of the flora of the southeastern USA: "Cultivated, disturbed areas, roadside ditches." North Carolina is included in Weakley's USA range by a map symbol; his key to species characterizes *E. crista-galli* as a "cultivated tree, persistent."

Isely (1990, p. 66) noted that "Small (1933) reported this species (as *Micropteryx crista-galli*) in waste places, Coastal Plain, Gulf States, and Krukoff and Barneby (1974) listed it from three southern states. Recent scanty documentation in our region is limited to Florida, and true establishment is doubtful." Isely also included *E. variegata* in his treatment, noting that "the species is "cultivated and persistent in urban areas, cp. S. Fla." Isely (1998) again included both non-native species: E *crista-galli*: "intr to s US. S FL, se TX, s CA; reported MS and GA (Krukoff & Barneby 1974). Cult and occasionally persistent in urban areas." And *E. variegata*: "intr in s US. Primarily urban s FL and CA. Cult and persistent."

The current listing of *Erythrina crista-galli* in the Georgia and Mississippi floras apparently is based on information cited in the PLANTS database as "Iowa State [College] Journal of Science 1941." If that citation is correct, then an allusion to the *Erythrina* may exist in one of the doctoral dissertation abstracts published in volumes 15 and 16 of that journal as it is not mentioned in any of the main articles. The species is not listed or mentioned in the Georgia checklist (Duncan & Kartesz 1981) or Georgia atlas (Jones & Coile 1988). The Mississippi checklist (McCook & Kartesz 2000) has included *E. crista-galli* specifically on the basis of the 1941 literature citation.

An early collection from Louisiana by Americus Featherman (NY!, without date or other information) notes that *Erythrina crista-galli* was "naturalized in the streets of Baton Rouge." The species was not listed or mentioned in Featherman's reports on his Louisiana flora survey (1871, 1872), so presumably the collection was made later. Featherman was a member of the Lousiana State University (Baton Rouge) faculty between 1869 and 1872 but he collected plants in Louisiana from 1858 until 1875 (Ewan 2005).

Allen et al. (2002, p. 94) noted that *Erythrina crista-galli* "is cultivated in Louisiana and persists with records from East Baton Rouge, East Carroll, Lafourche, Ouachita, and St. Charles parishes." The species was included for these parishes in the atlas of the Louisiana flora compiled by Thomas and Allen (1997) but it was not included in the atlas of McRoberts (1989). Specimens at NLU of *E. crista-gallii* are all from cultivated plants — 1 from East Carroll Par. in 1973, persistent at an old home site; 4 from Ouachita Par., all from within the city of Monroe, 1958-1983. All Louisiana collections of *E. crista-gallii* currently at LSU represent cultivated plants — East Baton Rouge, Lafourche, and St. Charles parishes; digital images via LSU online database.

As part of the Florida flora, *Erythrina crista-galli* is not documented at FSU, FTG, or USF (collections examined via online herbaria) and it is not included in the Florida Atlas (Wunderlin & Hansen 2013). It is not among the species included by Wunderlin & Hansen (2003) or Nelson (2012). A single individual within the city of Gainesville appears to represent the only documented instance of a plant growing outside of cultivation — it was collected twice in 2009, once in flower and once in fruit.

Florida. Alachua Co.: Gainesville, E side of NW 55th St., just N of 8th Ave, leaning out from woods, individual tree, flowering, 29 May 2009, *Vandiver s.n.* (FLAS, digital image!); Gainesville, E side of NW 55th St, just N of 8th Ave, leaning out from woods, individual tree, fruiting, 10 Jun 2009, *Jacono 742* (FLAS, digital image!).

A collection of *Erythrina crista-galli* made within the city of Houston was noted by the collector to represent an "escape," but there is no evidence or indication that the species has become naturalized there.

Texas. Harris Co.: downtown Houston, intersection of Montrose Blvd and Welch St, escaped into a vacant lot, 5 Aug 1991, *Brown 15516* (NLU, digital image!).

A flowering plant of *Erythrina crista-galli* probably about 2-3 years old was observed (but not vouchered) in 2007 growing where trash had been dumped at the end of a Croatan National Forest Service road near the Newport River estuary in Carteret Co., North Carolina (photos and information from John Fussell, fide Alan Weakley). There has been no further indication that additional plants have appeared at that site.

In sum, flowering plants of *Erythrina crista-galli* are spectacularly conspicuous and would draw the attention of any floristic botanist, but a documenting collection is known for only a few individuals that might have arisen spontaneously outside of cultivation. It is unlikely that the species is naturalized in the USA — most statements to the contrary are based on cultivated plants or those at sites where they persist from cultivation. Even though occasional, apparently spontaneously occurring plants have been encountered, their apparent lack of spread suggests they are better considered as waifs (e.g., Nesom 2000) than as part of the naturalized flora.

Erythrina falcata Benth. (Brazilian coral tree, evergreen coral tree, corticeira-da-serra)

Trees 10–20 meters tall, evergreen to semi-deciduous. Native to Brazil, Paraguay, and Argentina, Peru, and Bolivia (Burkart 1972). Flowering sometimes as early as late winter and continuing into summer, hardy to 20 degrees F. "We consider this tree to be mostly evergreen, though infrequently it can be seen bare when in flower and often there will be leafless sections that

allow the flowers to be better seen." "It is the largest of the coral trees grown in California and has been in cultivation in coastal California since the 1930s. ... This species is too large for many landscapes, ... has been more difficult to vegetatively propagate than other Coral Trees, and seed grown plants do not bloom for many years. More recently we have had more success rooting cuttings of this magnificent species and are able to offer cutting grown plants in limited quantities" (San Marcos Growers 2015). Burkart (1972) observed that flowering in cultivated trees occurred 11 years after being planted from seed, with trees reaching 10 meters tall after 14 years. See Etcheverry and Alemán (2005) for detailed information on reproductive biology.

Erythrina flabelliformis Kearney (coral, western coral bean)

Deciduous, mostly multi-stemmed shrubs 1.5–2 meters tall in the USA but becoming trees up to 9 meters in parts of Mexico. Native to Arizona and New Mexico and southward in western Mexico (Aguascalientes, Baja California Sur, Chihuahua, Durango, Jalisco, Michoacan, Sinaloa, Sonora, Zacatecas).

Erythrina humeana Spreng. (dwarf coral tree, Natal coral tree)

Shrubs 1–3 meters or rarely small trees to 4 meters tall; "Suffrutex with annual stems from a woody rootstock or shrub" (key in Mackinder 1993); "Suffrutex with woody rootstock, rarely a small tree to 4 m tall" (descriptions in Mackinder 1993 and Mackinder et al. 2001). Calyx campanulate, not lipped; corollas scarlet, keel petals fused along lower margins. Native to open grasslands of Swaziland and eastern South Africa. It is "deciduous from winter well into spring but blooms in late summer and fall, a completely different time of year than other coral trees" (San Marcos Growers 2015). The flowers are produced on leafy plants but the long, relatively loose inflorescences are high above the level of the leaves, which are weakly to strongly 3-lobed. Identified as "Erythrina humeana var. raja" and characterized as a "hybrid" by San Marcos Growers (2015), but *Erythrina raja* Hook. f. (= *E. humei* var. *raja* [Hook. f.] Harv.) was described in 1843 from a native plant of Natal.

Erythrina latissima E. Mey. (broad-leaf coral tree)

Deciduous trees 3–8 meters tall. Native to Botswana, Mozambique, Zimbabwe, Swaziland, and eastern South Africa. Characterized especially by densely tomentose stems, leaves, and calyces, large, broad leaves, at least when young, and thick, corky bark.

Erythrina lysistemon Hutch. (common coral tree, lucky bean tree)

Deciduous trees 3–12(–20) meters tall, with gray or gray-brown, smooth (not corky) but prickly bark. Native to Botswana, Malawi, Mozambique, South Africa, Swaziland, Tanzania, and Zimbabwe; naturalized in Australia.

Erythrina speciosa Andrews

Multi-stemmed shrubs or trees 3–5 meters tall, deciduous but less commonly flowering with leaves, crown broadly spreading and loosely open. Native to Brazil; naturalized in Australia (Norfolk Island). Consistently pink-flowered plants are a horticultural selection.

Erythrina x sykesii Krukoff & Barneby

Sterile hybrid apparently of garden origin in New Zealand, the parentage speculative — Krukoff and Barneby (1974) regarded *E. lysistemon* as one of the parents, based on calyx morphology, but found the identity of the second ambiguous; Spencer (2002) believed the parents to be *E. lysistemon* and *E. coralloides*. Deciduous trees 8–12(–15) meters tall with a wide-spreading crown, flowering mostly before the leaves but sometimes continuing after leaves appear; flowers orange, spreading-ascending on the rachis; calyx shallowly 2-lipped, 11–14 mm long. *Erythrina* x *sykesii* has become naturalized in New Zealand and in southern and eastern Australia, where it propagates via root suckers and stem layering (the stems are brittle and shed easily when windy).

Erythrina variegata L. (tiger's claw, lenten tree, coral tree)

Deciduous, fast-growing trees 10–15(–20) meters tall with a spreading crown (except in the cultivar 'Tropic Coral,' which is columnar and evergreen, often used for hedges). The leaves are variable in shape and size and sometimes variegated with yellow or pale green. Native to tropical Asia (Taiwan and southern China, Indonesia, Malaysia, Philippines, Indian Ocean islands, and India) and tropical east Africa. It has been widely introduced in cultivation in coastal areas of the Old World tropics and is commonly grown in the USA, at least in California and Florida.

ACKNOWLEDGEMENTS

I am grateful for use of the library and herbarium at BRIT, to Dennis Bell of providing access to digital images of the NLU herbarium, to John Pruski at MO and Barney Lipscomb at BRIT for help with literature, and to Alan Weakley at NCU for information on *E. crista-galli* in North Carolina.

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NOMENCLATURAL NOTE ON *EUGENIA MARITIMA* AND *MYRCIA POLYANTHA* (MYRTACEAE)

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ABSTRACT

Application of the names *Eugenia maritima* DC. and *Myrcia polyantha* DC., is discussed — these were proposed twice by de Candolle in the same publication — and validation is provided for the names involved: *Eugenia ilhensis* O. Berg, *Eugenia maritima* (Kunth) DC. (interpreted here as the correct name for *E. acapulcensis*), **Myrcia neopolyantha** Sobral & Mazine, **nom. nov.** (a replacement name for *Myrcia polyantha* DC.), and *M. splendens* (Sw.) DC. Comments are provided for additional varieties of *M. polyantha*.

Eugenia maritima and *Myrcia polyantha* were proposed twice by de Candolle in his treatment of Myrtaceae for the Prodromus (1828). In both cases, these names were proposed for a new species and for a combination based on a preexisting name. Since then, authors have either considered some of these names valid or merged them in the synonymy of other species (Berg 1855–1856; Steudel 1840; McVaugh 1963; Govaerts et al. 2015); nevertheless, some of these usages are not in accordance with current nomenclatural rules. Here we discuss these names and propose what we consider their correct application according to International Code of Nomenclature for Algae, Fungi and Plants (ICN – McNeill et al. 2011).

1. *EUGENIA MARITIMA*

Eugenia maritima DC. was proposed for a Brazilian species by de Candolle (1828: 271), while *Eugenia maritima* (Kunth) DC. (1828: 282) was based on the Mexican *Myrtus maritima* Kunth (1823). The Brazilian species was previously undescribed, while the Mexican species was a new combination based on a preexisting name. Article 11.4 of ICN (McNeill et al. 2011) states that "the correct name for one taxon below the rank of genus is the combination of the final epithet of the earliest legitimate name of the taxon in the same rank, with the correct name of the genus or species to which it is assigned," implying that *Eugenia maritima* (Kunth) DC., based on *Myrtus maritima*, the earliest legitimate name, has priority over *Eugenia maritima* DC., which was correctly renamed by Berg (1856) as *Eugenia ilhensis*.

1.1. ***EUGENIA ILHENSIS*** O. Berg, Linnaea 27: 212. 1856. *Eugenia maritima* DC., Prodr. 3: 271. 1828, nom. illeg. (not *E. maritima* (Kunth) DC.). TYPE: **BRAZIL**. Bahia. "In Brasiliae maritimis ad Ilheos," *Martius s.n.* (M).

1.2. ***EUGENIA MARITIMA*** (Kunth) DC., Prodr. 3: 282. 1828. *Myrtus maritima* Kunth, Nov. Gen. Sp. 6: 146. 1823. **Type: MEXICO**: "Crescit in maritimis prope Acapulco Mexicanorum," *Humboldt & Bonpland s.n.* (P – for image see P 2015b).

= *Eugenia acapulcensis* Steud., Nomencl. Bot. ed. 2, 1: 601. 1840, nom. illeg., replacement name for *Eugenia maritima* (Kunth) DC.

This species is widely variable and has been extensively discussed under *Eugenia acapulcensis* (see McVaugh 1963: 421).

2. ***MYRCIA POLYANTHA***

This name was used both for the Brazilian *Myrcia polyantha* DC. (1828: 252), a new species, and the Venezuelan *Myrcia polyantha* (Kunth) DC., (1828: 255) a new combination based in *Myrtus polyantha* Kunth (1823: 140). The application of Article 11.4 of ICN (McNeill et al. 2011, see above under *Eugenia maritima*) states that *Myrcia polyantha* (Kunth) DC., based on the preexisting legitimate name *Myrtus polyantha,* is valid over *M. polyantha* DC. The Kunthian species is a synonym of *Myrcia splendens* (Sw.) DC. (Govaerts et al. 2015), while *Myrcia polyantha* DC. is a valid eastern Brazilian species in need of a replacement name. Berg (1857–1859), in his treatment of Brazilian Myrtaceae, considered *Myrcia polyantha* under his genus *Aulomyrcia* O. Berg (Berg 1855–1856: 35), under which he proposed three varieties, two of which belong to other species and are properly synonymized below.

2.1. ***MYRCIA MULTIFLORA*** (Lam.) DC., Prodr. 3: 244. 1828. *Eugenia multiflora* Lam., Encycl. 3: 202. 1789. **Type: FRENCH GUIANA**. Cayenne, *Stoupy s.n.* (P).

= *Aulomyrcia polyantha* (DC.) O. Berg var. *parviflora* O. Berg, Fl. Bras. 14(1): 82. 1857. **Type: BRAZIL**. "Inter urbes Vittoria et Bahia," *Sellow s.n.* (B, probably lost; probable isotypes K, P; for image see P 2015a).

The specimens at K and P do not have the label information cited in the protologue; nevertheless, both are identified in Berg's handwriting.

2.2. ***MYRCIA NEOPOLYANTHA*** Sobral & Mazine, **nom. nov.** Replacement name for *Myrcia polyantha* DC., Prodr. 3: 252. 1828 (not *Myrcia polyantha* (Kunth) DC.). *Aulomyrcia polyantha* (DC.) O. Berg, Linnaea 27: 50. 1856. *Aulomyrcia polyantha* (DC.) O. Berg var. *coriacea* O. Berg, Fl. Bras. 14(1): 82. 1857, nom. illeg. (= *Aulomyrcia polyantha* var. *polyantha*). **Type: BRAZIL**. "In Brasiliae campestribus apricis desertis provinciae Bahiensis," *Martius s.n.* (M; for image see M 2015a).

2.3. ***MYRCIA NEOROSTRATA*** Sobral, Novon 16: 136. 2006, replacement name for *Aulomyrcia rostrata* O.Berg, Fl. Bras. 14(1): 544. 1859. **Type: BRAZIL**. Bahia: 1880, *Blanchet s.n.* (LE, photo; isotype OXF, photo).

= *Aulomyrcia polyantha* (DC.) O. Berg var. *membranacea* O. Berg, Fl. Bras. 14(1): 82. 1857. **Type: BRAZIL**. "In campestribus apricis supra granitidem, prope S. Anna in desertis," *Martius s.n.* (M; for image see M 2015b).

2.4. ***MYRCIA SPLENDENS*** (Sw.) DC., Prodromus 3: 244. 1828. *Myrtus splendens* Sw., Prodr.: 79. 1788. **Type: HISPANIOLA**. *Swartz s.n.* (S).

= *Myrcia polyantha* (Kunth) DC., Prodromus 3: 255. 1828. *Myrtus polyantha* Kunth, Nov. Gen. Sp. 6: 140. 1823. **Type: VENEZUELA**. "Crescit ad ripam fluminis Atabapi, Misiones del Orinoco" *Humboldt & Bonpland s.n.* (P; for image see P 2015c).

For complete synonymy of this variable species, see Govaerts et al. (2015).

ACKNOWLEDGEMENTS

We are grateful for the curators of the herbaria cited, either for their help along our visits and for their efforts in making their type collections freely available online.

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STUDIES OF NEOTROPICAL COMPOSITAE–X. REVISION OF THE WEST INDIAN GENUS *NARVALINA* (COREOPSIDEAE)

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ABSTRACT

The genus *Narvalina*, long known solely from the single species *Narvalina domingensis*, presumably discovered by Surian and Plumier between 1689–1691, is expanded to include a second species, **Narvalina antrorsa** Pruski, **sp. nov.** Both species of *Narvalina* are endemic to the West Indian island of Hispaniola. *Narvalina* is characterized by its shrubby habit, fertile ray florets, and alate cypselae, but *Narvalina antrorsa* differs from the generitype by antrorsely barbed pappus awns; in this regard it seems to approach monotypic exalate-fruited *Selleophytum*, another shrubby Coreopsid also endemic to Hispaniola. The history of the misapplication of continental *Lasianthaea fruticosa* to West Indian *Narvalina domingensis* is summarized.

Narvalina Cass. (Compositae: Coreopsideae) is traditionally recognized as a monotypic genus endemic to the West Indian island of Hispaniola (Candolle 1836; Bentham and Hooker 1873; Blake 1915, 1923; Sherff and Alexander 1955; Bremer 1994; Liogier 1999; Panero 2007; Crawford et al. 2009). This genus of shrubs often has petiolate holly-like leaves, and is characterized by obcompressed alate fruits (Figs. 1, 6, 10) and fertile ray florets. Other shrubby Coreopsid genera distinguished from *Narvalina* typically have exalate fruits (e.g., *Selleophytum* Urban; viz fig. 2b) or sterile ray florets (e.g., *Coreopsis* L. s. lat.).

Narvalina was likely first collected and illustrated on the joint expedition by Surian and Plumier between 1689–1691. Shortly thereafter the plant appeared in the literature as the polynomials "*Bidens frutescens, ilicis folio, flore luteo*" (Plumier 1703: 10), "*Bidens Americana, frutescens, ilicis folio, flore luteo*" (Tournefort 1719: 462), and "*Ceratocephalus ilicis foliis*" (Vaillant 1722: 326). The genus was described validly as *Needhamia* Cass. (non Scop., 1777, Fabaceae) by Cassini (1825a), who drew attention to the obcompressed alate biaristate fruits. Soon thereafter, Cassini (1825b) provided the new generic name *Narvalina* to replace his valid albeit illegitimate later homonym *Needhamia*. Lessing (1832) provided the needed new binomial combination *Narvalina domingensis* (Cass.) Less. for the sole species then placed in the genus.

After Plumier's death, his illustration drawn 50 years earlier appeared belatedly in Burman (1756: 42, tab. 52, as "*Verbesina frutescens, foliis ovatis ac serratis*"; reproduced here as Fig. 1). Linnaeus (1759, 1763) under *Verbesina fruticosa* (L.) L. gave Plumier's illustration and the accompanying Burman phrase name in synonymy, and Urban (1907) synonymized *N. domingensis* under his new *Narvalina fruticosa* (L.) Urban. Plumier's West Indian plate (in Burman 1756: tab. 52), was a century ago identified as a resurrected *N. domingensis* by Blake (1915), who excluded *N. fruticosa* from *Narvalina*. Becker (1979) treated the Linnaean species as continental *Lasianthaea fruticosa* (L.) Becker of Heliantheae subtribe Ecliptinae. Although Hieronymus (1900) described three South American subscandent to vining Coreopsids as Narvalinas, these were quickly dispatched by Blake (1923) to *Cyathomone* and *Ericentrodea* (Compositae: Coreopsideae). Thus, basically since Surian and Plumier discovered this West Indian plant in the 1600s, *Narvalina* was known from only its generitype, but here three centuries after the type of the genus was first collected the genus is with some hesitation expanded to include a second species, *Narvalina antrorsa*, also endemic to Hispaniola.

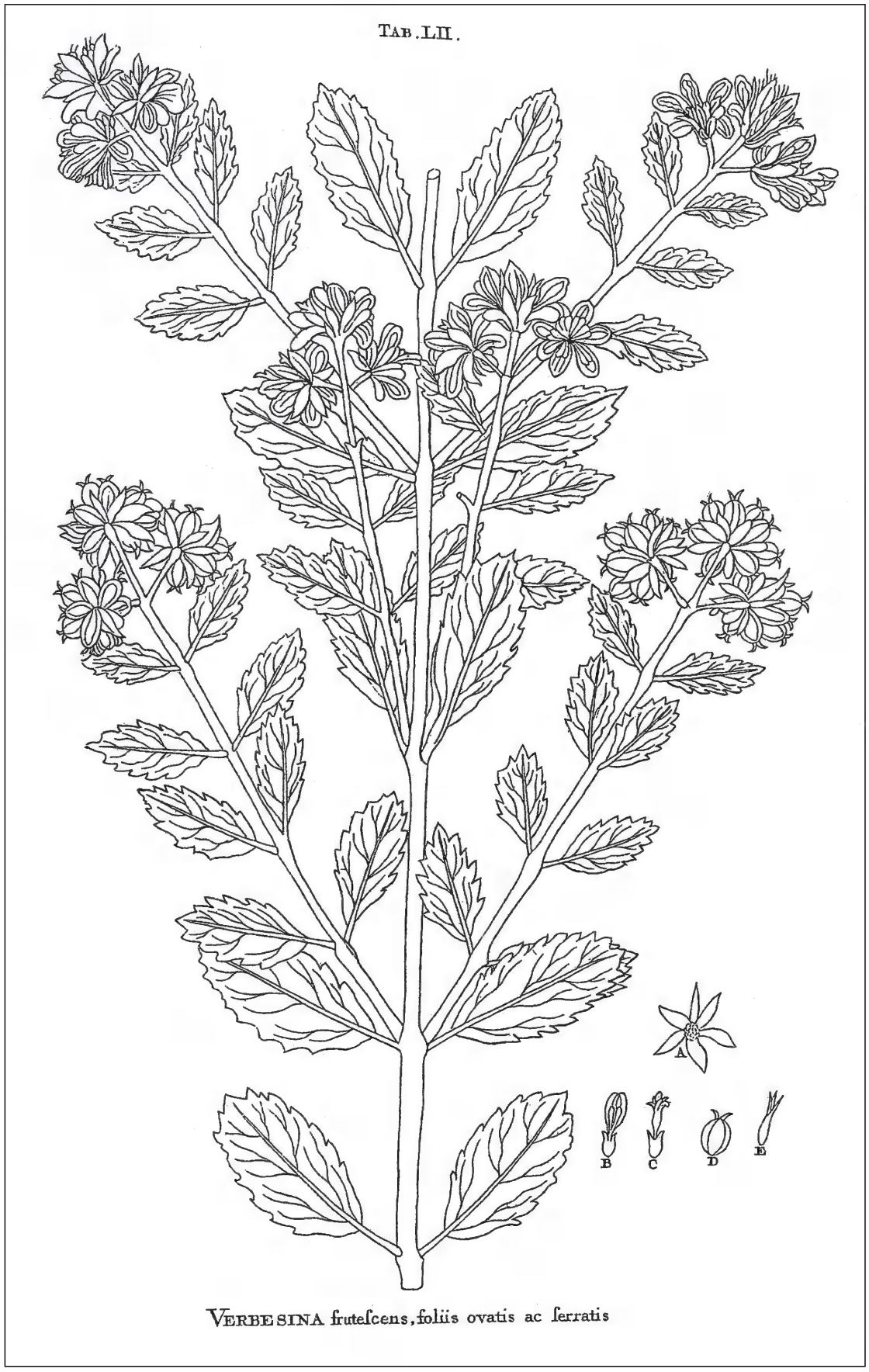

Figure 1. Illustration of *Narvalina domingensis* showing alate biaristate cypselae (lower right, D). This illustration by Charles Plumier (as copied by Claude Aubriet for Herman Boerhaave), who died in 1704, was misidentified for more than two centuries, and was recognized as *Narvalina domingensis* by Blake (1915). Plumier's drawings are often based on collections from Haiti of Joseph Surian housed in his ten folios at P. Surian and Plumier are not known to have visited the Cordillera Central, i.e., within the range of moderately similar *Narvalina antrorsa*. Plumier's own collections from two expeditions after Surian's 1691 death were supposedly lost at sea, and thus do not voucher his illustrations. Reproduced from Burman 1756, tab. 52, as the polynomial *Verbesina frutescens, foliis ovatis ac serratis*.

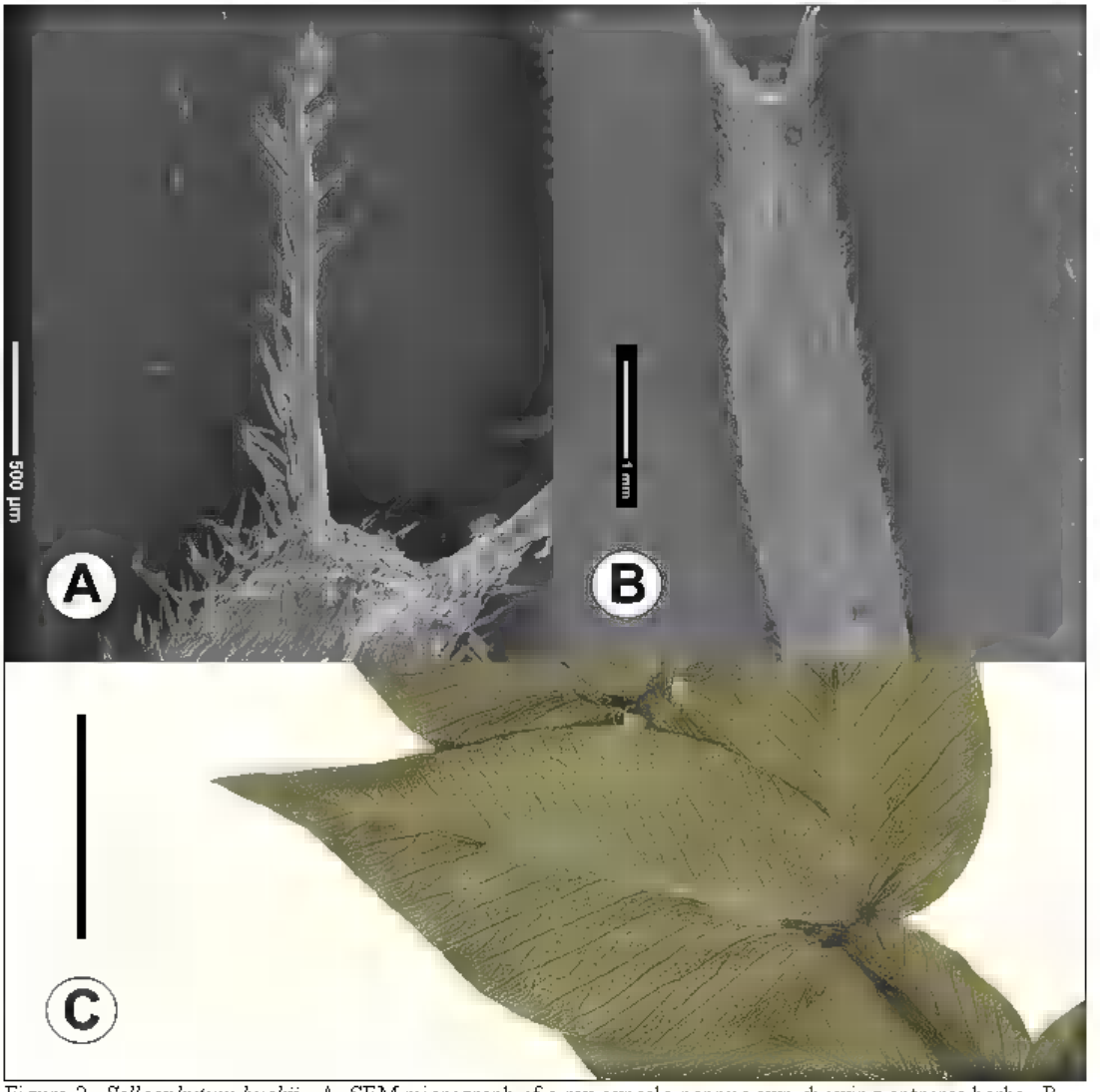

Figure 2. *Selleophytum buchii*. A. SEM micrograph of a ray cypsela pappus awn showing antrorse barbs. B. SEM micrograph of an exalate disk cypsela. C. Sessile leaf showing cordate base and entire margins. All from *Pruski & Ortiz 4076*, MO; scale bar C is 2 cm.

While the characters including retrorse-barbed pappus awns in *Narvalina* have until now been viewed as consistent, the six collections referred here to *Narvalina antrorsa* have antrorsely barbed pappus awns. Thus by recognition of an expanded *Narvalina*, a former useful character of *Narvalina*, i.e., the retrorse barbed pappus awn character, is with some hesitancy discarded. By antrorse pappus awn barbs as well as by cypselae faces distally hirsutulous (see Figs. 2, 6), *N. antrorsa* is similar to monotypic Hispaniolan endemic *Selleophytum*, which in molecular studies was recovered as sister to *Narvalina* by each Kimball and Crawford (2004), Mort et al. (2008), Crawford et al. (2009), and Mesfin Tadesse and Crawford (2014). However, cypsela pubescence appears not to be overly important in Coreopsid generic-level taxonomy. Possibly lessening the significance of antrorse barbs being found in each *N. antrorsa* and *S. buchii* Urban is the fact that Gray (1862) noted that on rare occasions both retrorse and antrorse barbed pappus awns may be found even within

individual species of Coreopsideae. Moreover, large-capitulate *S. buchii* by its exalate fruits and sessile cordiform leaves with entire margins (see Fig. 2) seems very different from both species of *Narvalina*. With the reproductive character lability inferences of Gray (1862) and Kimball and Crawford (2004) in mind, the circumscription of *Narvalina* is broadened here to include a second vegetatively similar species. My aim here is basically to validate *Narvalina antrorsa* and comment on its generic placement, largely as interpreted from the suite of specimens of these three species in two genera (*Narvalina* and *Selleophytum*), SEM micrographs of their fruits, and literature now in front of me.

NARVALINA Cass. in F. Cuvier (ed.), Dict. Sci. Nat. (ed. 2) 38: 17. 1825. (see also Cass. in Dict. Sci. Nat. (ed. 2) 59: 320. 1829, 60: 614. 1830). *Needhamia* Cass. in F. Cuvier (ed.), Dict. Sci. Nat. (ed. 2) 34: 335. 1825 (non *Needhamia* Scop., 1777, Fabaceae). **TYPE**: *Needhamia domingensis* Cass. (≡ *Narvalina domingensis* (Cass.) Less.).

Shrubs 1–3 m tall; stems erect, subterete, striate, glabrous or weakly pubescent, leafy distally, pith solid; herbage without latex. **Leaves** simple, opposite, petiolate, isomorphic; blade stiff, midrib broad and slightly raised abaxially, venation pinnate, secondary veins at about 60° to midrib, secondary veins basically immersed or sometimes at least in dried material slightly raised adaxially, surfaces glabrous or very nearly so, margins toothed, teeth evenly spaced; petioles basically exalate but opposing leaves narrowly to indistinctly subclasping. **Capitulescence** terminal, erect, narrowly cymose to open-corymbiform or nearly umbellate, ultimate branching usually opposite but sometimes subopposite or alternate. **Capitula** radiate, moderately small; involucre cylindrical to narrow-campanulate, base nearly truncate or at least so in dried material, somewhat gibbous-based post-fruit; phyllaries 2(–3)-seriate and dimorphic, free to base, outer series of phyllaries differing from inner series in texture and color, at least the inner series of phyllaries persistent; outer phyllaries 2–5, ascending to reflexed, shorter than the inner ones, subherbaceous and at least distally green, indistinctly 1–3-nerved, margins entire; inner phyllaries 3–5, broad-lanceolate, ascending-erect, greenish-yellow, striatulate, stiff-chartaceous with narrowly hyaline-scarious margins, becoming indurate especially in fruit, not widely spreading in fruit; clinanthium flat to convex, paleate; paleae slightly navicular, chartaceous but becoming indurate in fruit, yellowish-stramineous, few-striate, falling only well past fruit dispersal. **Ray florets** 2–5, pistillate, uniseriate; corolla yellow, limb shortly exserted, nerves with paired resin canals seen best among the specimens in front of me in adaxial view, apex minutely lobed. **Disk florets** 5–19, bisexual; corolla narrow-funnelform, 5-lobed, yellow, throat with broad nerves when dried with or without clear separation of paired resin ducts, glabrous or subglabrous; anthers ecaudate, yellowish, filaments glabrous, endothecial pattern polarized, appendage longer than wide, eglandular, with a proximal central colored resin duct to near midpoint or on occasion continuing as thin dark resin duct to apex; style appendiculate, branches slightly dilated, stigmatic surfaces seemingly continuous. **Cypselae** alate or a few inner ones rarely weakly alate, typically nearly isomorphic although disk cypselae wings less developed than in the rays, strongly obcompressed or rarely a few disks weakly so, erostrate, apex truncated, body dark brown but apparently not papillate-carbonized, cells quadrangular in longitudinal rows with dark secretions on both radial and tangential cells walls (surface ornamentation Type A in Mesfin Tadesse and Crawford 2014), usually 1–few striate-costate but otherwise smooth, never tuberculate, wings stramineous-brownish, entire, antrorsely ciliate, slightly thickened, never thin-membranous, base flat, carpopodium inconspicuous and annular; pappus awns 2 or in weakly alate interior disks rarely 3–4-awned, subequal, stramineous, somewhat stout although sometimes broken off, triquetrous-subulate, adaxial surface flattened basally in plane perpendicular to that of cypselae body flattening, antrorsely or retrorsely barbed along the two adaxial edges as well as abaxially.

Panero (2007) placed *Narvalina* in subtribe Coreopsidinae and gave the bisexual disk flowers as "functionally staminate," as is characteristic of the *Petrobium* R. Br. generic group of Kimball and

Crawford (2004). The disk florets of *Narvalina* prove instead to be bisexual, with those of each species setting fruit. The genus *Narvalina* is further diagnosed by its shrubby habit, pistillate ray florets, and obcompressed erostrate alate biaristate cypselae.

Narvalina is recognized here as containing two species, each endemic to Hispaniola. Four other names referred at one time or another to *Narvalina* are based on material from continental America and have been excluded from *Narvalina*. Three South American former Narvalinas are now placed in either *Cyathomone* S.F. Blake and *Ericentrodea* S.F. Blake & Sherff (Blake 1923). A fourth excluded name is the weak-compressed, biaristate- and exalate-fruited taxon now recognized as continental *Lasianthaea fruticosa* (Becker 1979). *Lasianthaea fruticosa* was recognized as *N. fruticosa* by Urban (1907) and Schulz (1911), who thought it was the plant illustrated as tab. 52 by Plumier in Burman (1756) as "*Verbesina frutescens, foliis ovatis ac serratis.*" However, Blake (1915) and Urban (1920, 1921) each correctly determined Plumier's tab. 52 in Burman as *N. domingensis*. Although suggested as or formally treated earlier as synonyms (Burman 1756; Linnaeus 1759, 1763; Sprengel 1826; Candolle 1836; Urban 1907; and Schulz 1911), *Lasianthaea fruticosa* and *N. domingensis* are heterotypic, allopatric, and now placed in different tribes of Compositae.

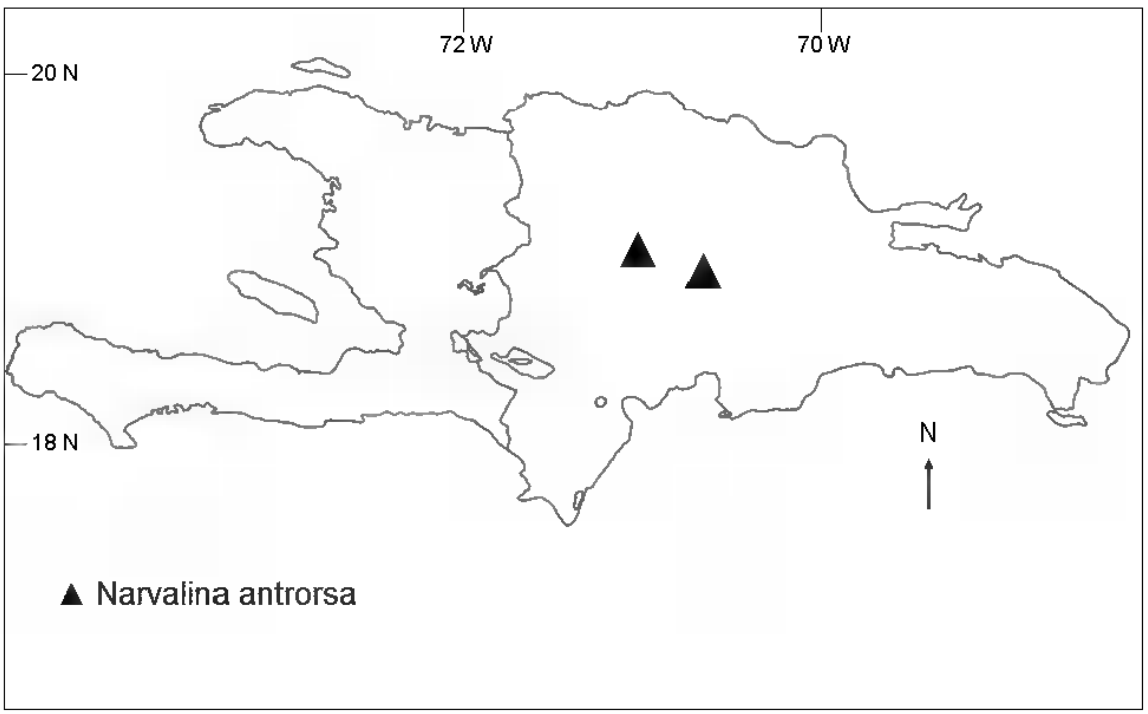

Figure 3. Distribution of *Narvalina antrorsa*.

1. Leaf blades not appearing pellucid-dotted, margins mildly crenate-serrate, teeth ca. 1 mm deep, usually forward-directed or sometimes slightly spreading, obtuse callous-tipped; ray florets typically 5, disk florets 10–19; cypsela face apices hirsutulous, pappus awns antrorsely barbed ..... **Narvalina antrorsa**

1. Leaf blades appearing pellucid-dotted, margins sharply serrate-dentate, teeth 1–2 mm deep, often spreading laterally, sharply and stiffly callous-tipped; ray florets typically 2–3, disk florets 5–8; cypsela faces subglabrous, pappus awns retrorsely barbed ..... **Narvalina domingensis**

NARVALINA ANTRORSA Pruski, **sp. nov. TYPE: DOMINICAN REPUBLIC. Santiago.** Cordillera Central, Municipio San José de Las Matas, comunidad Mata Grande, subida del Valle del Bao, A. Bermúdez, 2109-479 N, 285-771 E [= 19° 04' 01" N, 71° 02' 09" W], 1600–1700 m, 3 Dec 2001, *T. Clase, R. Ramírez, M. Pérez & M. Calzada 3202* (holotype: MO; isotype: JBSD). Figures 3–6.

MISSOURI
BOTANICAL GARDEN
HERBARIUM
Nº 6615473
Holotype of:
3202
Narvalina antrorsa Pruski
Ref. [19°04'01"W, 71°02'09"W]
det. John Pruski, 2009
Missouri Botanical Garden (MO)
JARDÍN BOTÁNICO NACIONAL DR. RAFAEL M. MOSCOSO
SANTO DOMINGO, REPUBLICA DOMINICANA
3202 Asteracea
Arbusto de 2 m, con flores y frutos.
República Dominicana: Cordillera Central, Provincia Santiago, Municipio San José de Las Matas, comunidad Mata Grande, subida del Valle del Bao, A. Bermúdez.
2109-479 N, 285-771 E, Elev. 1600-1700 m.
3 de Diciembre, 2001.
T.Clase, R. Ramírez, M. Pérez & M.Calzada.
0 1 2 3 4 5 6 7 8 9 10
cm
copyright reserved
MISSOURI BOTANICAL GARDEN

Figure 4. Holotype of *Narvalina antrorsa* (*Clase et al. 3202*, MO).

Fruticosa 2–3 m alta; folia petiolata, lamina 2–6 × 1.5–3 cm elliptica-obovata vel obovata nec pellucida crenata-serrata; capitulescentia laxe corymbiforma, ramuli 7–13-capitulati; capitula radiata circiter 10 mm alta; involucrum circiter 4 mm diam.; phyllaria valde 2-seriata, externa 2–5, 2–4 × 0.5–0.9 mm, interna circiter 5, 8–9.3 × 2–3 mm; flosculi radiati 5 pistillati; flosculi disci 10–19, corollis 4.1–5.4 mm longis, lobis 0.6–0.8 mm longis; cypselae alatae, setae pappo 2(3–4), 2.2–3 mm longae.

Shrubs 2–3 m tall; stems branched distally, distal portions (as seen on herbarium specimens) 2–4 mm diam., brown, basically glabrous throughout or sometimes sparsely hirtellous-puberulent. **Leaves** petiolate; blade 2–6 × 1.5–3 cm, elliptic-obovate to obovate, chartaceous, usually with 3–7 widely spaced secondary veins, not appearing pellucid-dotted, base cuneate, margins mildly crenate-serrate, teeth 3–7 per side, ca. 1 mm deep, usually forward-directed or sometimes slightly spreading, obtuse callous-tipped, apex usually broadly acute to rounded; petiole 0.5–1.5 cm long, opposing leaves forming a small ridge but usually indistinctly subclasping. **Capitulescence** open-corymbiform to nearly umbellate, branchlets mostly 7–13-capitulate, moderately ascending, glabrous or at least subglabrous, ultimate capitula always pedunculate; peduncles 3–40 mm long, stout, often drying costate-sulcate, glabrous or at least subglabrous. **Capitula** 9–13 mm long; involucre 4-6 mm diam.; phyllaries clearly biseriate and dimorphic especially in bud, obviously unequal but outer phyllaries often withered in fruiting material which often seems to show only the equal and isomorphic inner phyllaries; outer phyllaries 2–5, 2–4 × 0.5–0.9 mm, lanceolate, spreading to reflexed, loosely subtending involucre to sometimes decurrent onto peduncle, much smaller and narrower than the inner, green, indistinctly 1–3-nerved, obviously noncontiguous at base, margins entire, eciliate, apex obtuse; inner phyllaries ca. 5, directly subtending and in one-to-one association with a ray floret, 8–9.3 × 2–3 mm, finely striatulate but striae embedded; clinanthium flat, 2–2.7 mm diam.; paleae 8.5–9.4 × 1–1.5 mm, about as long as cypselae with pappus, narrowly oblanceolate but otherwise more or less similar to inner phyllaries, reaching to about middle of disk corolla throat. **Ray florets** typically 5; corolla limb 4–5.5 × ca. 2 mm, 5-nerved, long-papillose in bud. **Disk florets** 10–19; corolla 4.1–5.4 mm long, glabrous or lobes sparsely long-papillose pre anthesis, tube ca. 1.5 mm long, the narrow throat with closely paired resin ducts visible distally, often appearing as single proximally, lobes 0.6–0.8 mm long, triangular-lanceolate; anthers and styles yellow, concolorous with ray and disk corollas; anthers 1.6–2.6 mm long, anther collar ca. 0.3 mm long, longer than the short-sagittate thecae, appendage 0.4–0.5 mm long, lance-ovate; style branches 0.8–0.9 mm long, apex narrowed. **Cypselae** strongly obcompressed or inner ones sometimes only slightly so, body slightly shorter than to about as long as phyllaries but pappus awns typically at least partly exserted, faces glabrous or very sparsely hirtellous proximally, apex hirsutulous, wings moderately thin, tan, moderately ciliate, cilia ca. 0.5 mm long, spreading; ray cypselae 3.5–6 × 1.5–2 mm, elliptic-ovate in outline, the body to ca. 1 mm diam., each wing to ca. 0.5 mm diam.; disk cypselae 5–9 × (0.5–)1–1.8 mm, narrowly oblanceolate or oblong in outline, wings 0.2–0.5 mm diam.; pappus awns 2(3–4), 2.2–3 mm long, subequal or with 1 or 2 shorter awns less well-developed than lateral ones, adaxial surface flattened at very base in plane perpendicular to that of cypselae body flattening, then awns distally quickly flattened in plane parallel to that of cypselae body flattening, antrorsely barbed, barbs 0.1–0.2 mm long, irregular, closely spaced, often obviously more well-developed on outer-abaxial edge.

Paratypes: **DOMINICAN REPUBLIC**. **La Vega**. Cordillera Central, Constanza, al sureste del poblado de Pinalito, en la confluencia del Arroyo Madre Vieja y el Rio Tireo, 18° 55' N, 70° 37' W, 1300–1350 m, 7 Feb 1986, *Garcia & Peláez 994* (JBSD, MO). **Santiago**. Cordillera Central, Municipio San José de las Matas, seccion Mata Grande, Parque Nacional Armando Bermudez, colectada en la subida del valle de Bao 1 km antes del valle, s. elev., 23 Mar 1999, *Clase & Peruero 1024* (JBSD, MO); Cordillera Central, Municipio San José de las Matas, sección Mata Grande, en Montes Prietos, en la cabezera del Río Bao, Parque A. Bermúdez, 286-581 N, 2107-430 E, [= 19° 02' 55" N, 71° 01' 41" W], 1760 m, 24 Mar 1999, *Clase & Peruero 1039* (JBSD, MO); Cordillera Central, on slope from Baito to El Valle, upper Bao Valley, 1500 m, 1–7 Oct 1968, *Liogier 12840* (NY, P); San José de las Matas, Loma del Valle de Bao, 1700 m, 31 Dec 1969, *Marcano 5757* (NY).

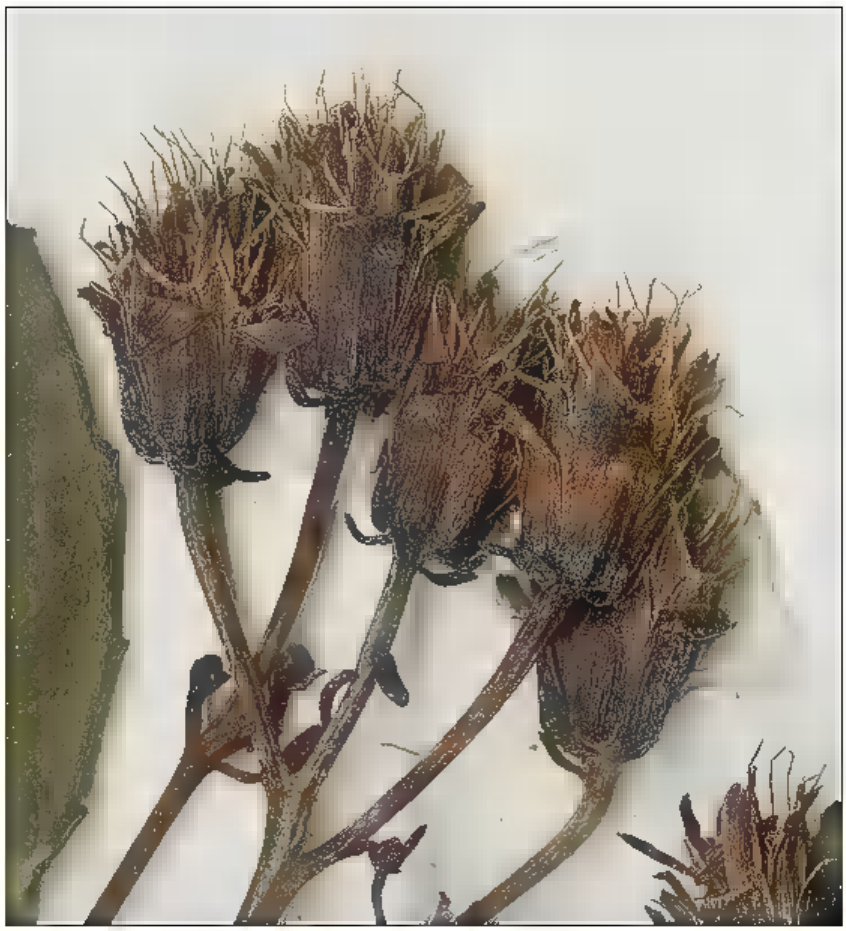

Figure 5. Close-up from Figure 4 of capitula of *Narvalina antrorsa* showing the outer series of short spreading to reflexed phyllaries (*Clase et al. 3202*, MO). The leaf margin on left shows the obtuse teeth.

Etymology, distribution, and ecology. *Narvalina antrorsa*, the epithet of which alludes to its antrorsely barbed pappus awns, is known from 1300–1760 meters in elevation in humid broadleaf forests and cloud forests in the Cordillera Central of La Vega and Santiago, Dominican Republic, where it appears to be endemic. *Narvalina antrorsa* has been collected in flower and fruit from October to March, namely when *N. domingensis* is less commonly found flowering. *Narvalina antrorsa* appears to be occasional at least in the Valle de Rio Bao. One collection appears to be from a loma, but I do not know whether or not other collections of *N. antrorsa* were found on granitic substrates.

Narvalina antrorsa was long known to me from only three collections: two made in 1960s by Drs. Liogier and Marcano, and the third from 1986 by my friend Ricardo Garcia of JBSD. During a 2006 visit to the Dominican Republic, Teodoro Clase (also of JBSD), with whom I had the pleasure of recently publishing *Ageratina nubicola* Pruski & Clase (2012), brought to my attention three more recent collections (two from 1999, and another made in 2001). Although the earlier collections known to me are good representatives of *N. antrorsa*, *Clase et al. 3202* is also complete and is designated as the type.

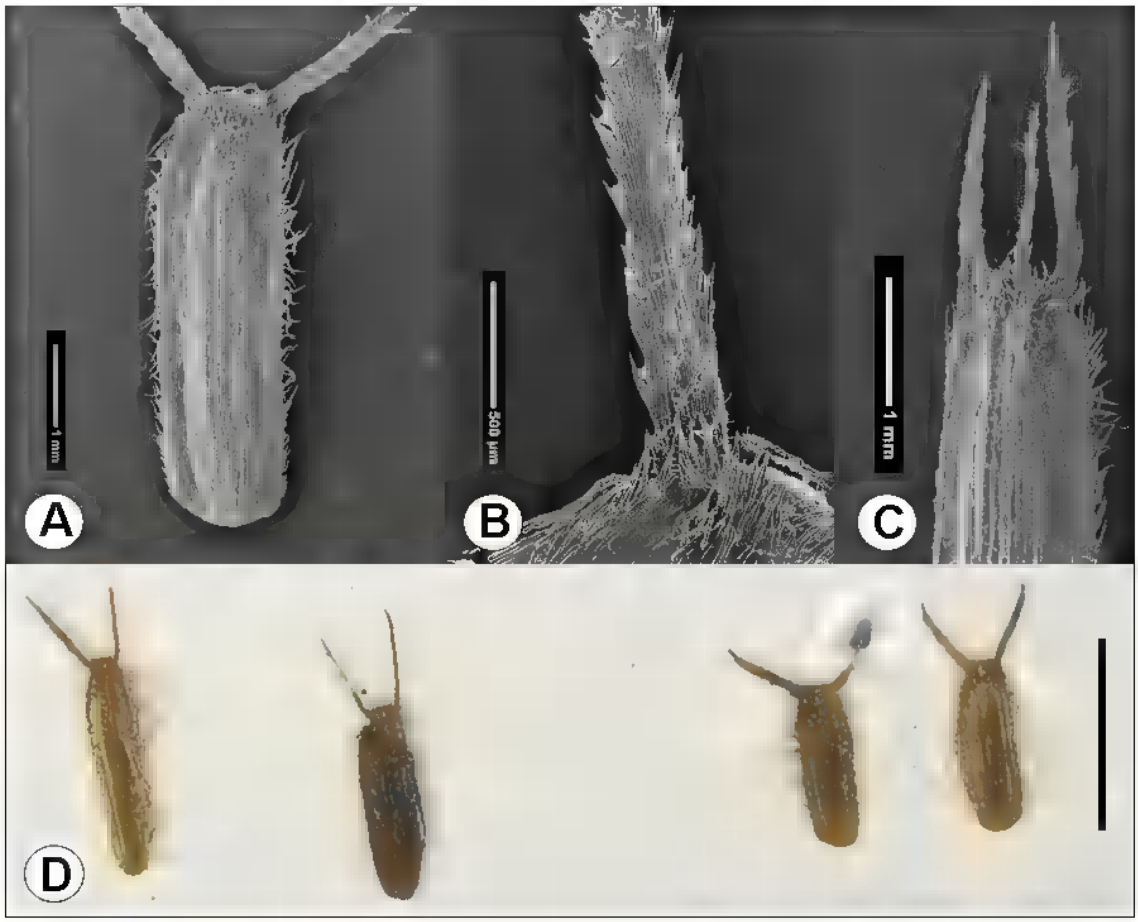

Figure 6. *Narvalina antrorsa*. SEM micrographs and photograph of cypselae and pappus awns. A. Ray cypsela, showing lateral wings narrower than body. B. Ray cypsela awn close-up showing antrorse barbs. C. Atypical interior disk cypsela showing poorly developed wings and 3 awns. D. Two disk cypselae (left) and two ray cypselae (right); the stramineous-brownish lateral wings are slightly narrower than the black bodies. All from *Clase et al. 3202*, MO; scale bar D is 5 mm.

At one point I thought the antrorse awns in the relatively large capitula in *Liogier 12840* and *Marcano 5757* each originally determined by Alain Liogier as *Narvalina domingensis* were mirages. Subsequently however, this feature was seen to remain consistent in a third gathering, *García & Peláez 994*. Dissections of these three early collections, along with observations of the three more recent collections received as gift for identification in 2009, confirm this "non-*Narvalina*-like" feature, which resembles the antrorse-barbed awns of *Selleophytum* (viz fig. 2). Further distinctions of the new species may be found in its non-pellucid dotted non-spinose-margined leaves, more florets per capitulum, shorter spreading to reflexed outer series of phyllaries, and distally hirsutulous cypselae faces. I do not believe that fertile-fruited non-hybrid *N. antrorsa* is an off-season variant of the common allopatric *N. domingensis*.

NARVALINA DOMINGENSIS (Cass.) Less., Syn. Gen. Compos. 234. 1832. *Needhamia domingensis* Cass., Dict. Sci. Nat. (ed. 2) 34: 336. 1825. **TYPE. HISPANIOLA** (as "Ile de Saint-Domingue). 1788, *Nectoux s.n.* (holotype: P n.v., as "dans l'herbier du Museum, ou M. Desfontaines nous a permis de l'observer"; possible isotype: K p.p., fragments in packet above the branchlet, fragment packet reads "S. Domingo - Nectoux"). Figures 1, 7–9.

MISSOURI
BOTANICAL GARDEN
HERBARIUM
№ 6615472
MISSOURI BOTANICAL GARDEN
0 1 2 3 4 5 6 7 8 9 10
cm
copyright reserved
CARIBBEAN
ASTERACEAE [280]
Narvalina domingensis (Cass.) Less.
det. John Pruski (MO), 2006
Dominican Republic: Pedernales Province
Sierra de Bahoruco (southern side).
Parque Nacional Sierra de Bahoruco,
uphill from Las Mercedes, open rocky
pinelands on slopes along broad paved
road near marker for KM 28.
18°07'19"N 071°37'03"W 940 m
Shrub to 2 m tall; lvs stiff, pellucid-
dotted, teeth sharp spreading; capitula
short-radiate; corollas, styles, and
anthers yellow; rays 3, pistillate;
disks 8; cypselae winged, obcompressed,
2-awned, barbs retrorse.
29 June 2006
John Pruski & Rosa Ortiz 4069
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)

Figure 7. Representative specimen of *Narvalina domingensis* (*Pruski & Ortiz 4069*, MO).

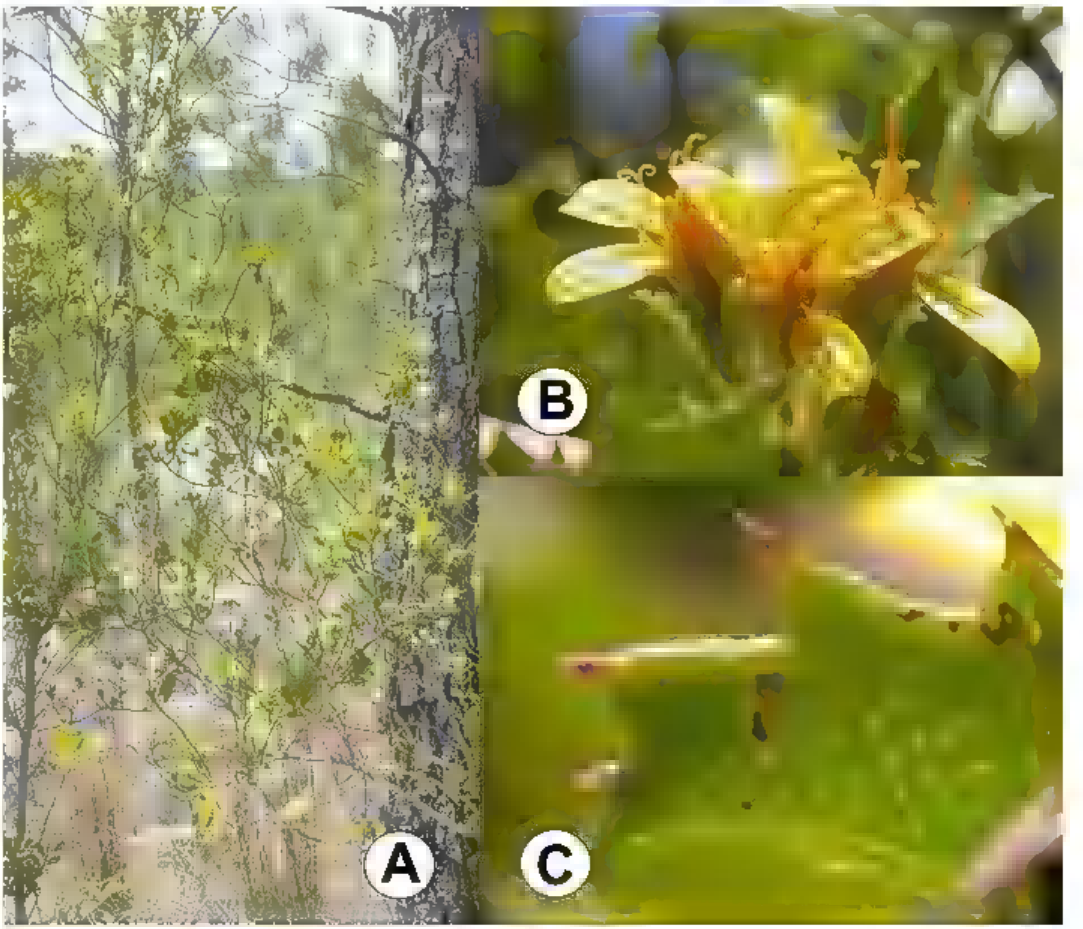

Figure 8. Field photographs of *Narvalina domingensis*. A. Habit foreground, habitat background. B. Close-up of flowering capitula. C. Leaf showing sharp marginal teeth and pellucid dots. All from *Pruski & Ortiz 4069*.

Shrubs, at least sometimes virgate, 1–3 m tall; stems 1-few from base, main stems usually stiffly erect, brittle, and weakly branched proximally, becoming moderately branched distally, puberulent or crisped puberulent distally on young vegetative branchlets or immediately below capitulescence, otherwise basically glabrous nearly throughout, petiole base sometimes persistent and in slow-growing short-internode plants the stems thereby appearing knotted. **Leaves** petiolate; blade 0.8–5 × 0.6–2.5 cm, holly-like, elliptic or oblong to obovate or spatulate, subcoriaceous, usually with 3–5 widely spaced secondary veins at about 60° to midrib, veins lucidous, appearing pellucid-dotted or streaked, dots associated with veins and not with areoles, base cuneate to attenuate, margins sharply serrate-dentate, teeth 3–9 per side, 1–2 mm deep, often spreading laterally to sometimes slightly forward-directed, sharply and stiffly callous-tipped, apex acute or usually obtuse to rounded, sometimes even nearly retuse; petiole 0.3–1.1 cm long, opposing leaves narrowly subclasping. **Capitulescence** narrowly cymose, branchlets 3–11-capitulate, strongly ascending, often somewhat puberulent or crisped puberulent, ultimate capitula sometimes subsessile ternate-clustered; peduncles stout, 1–20+ mm long, sometimes flattened or at least drying so, often somewhat puberulent or crisped puberulent. **Capitula** 8–12 mm long; involucre 3–6 mm diam., phyllaries slightly unequal; outer phyllaries ca. 3, 5–6 × 1–1.5 mm, lanceolate to oblanceolate, ascending to slightly spreading, often more than half as long as but narrower than the inner, stiff and apex sometimes callous-tipped,

distally green-herbaceous, slightly noncontiguous at base, margins often ciliate distally; inner phyllaries 3–5, a few often directly subtending ray florets, 6–9 × 2–2.5 mm, ca. 10-striatulate; paleae narrowly lanceolate but otherwise more or less similar to inner phyllaries, at anthesis reaching to near disk corolla lobe bases. **Ray florets** 2–3; corolla tube 2.5–3 mm long, limb 7–8 × 2–3 mm, oblong, partly exserted, 5–7-nerved; style well-exserted from tube, exserted portion of style often longer than the corolla tube. **Disk florets** 5–8; corolla 5–7 mm long, glabrous, tube 1.5–2.5 mm long, the narrow throat much longer than either tube or lobes, with closely and indistinctly paired resin ducts, lobes 0.6–0.7 mm long, triangular-lanceolate, recurved; anthers and styles yellow, concolorous with ray and disk corollas; anthers ca. 3 mm long, appendage ca. 0.7 mm long, lanceolate; style branches to ca. 1.5 mm long, recurved, caudate-appendage 0.5–0.6 mm long, triangular, abaxially papillose but sweeping papillae of appendage not extending proximally onto branch surface. **Cypselae** strongly obcompressed, at maturity to 7–9 mm long and about as long as the involucre, alate, faces subglabrous, wings tan, sparsely ciliolate, cilia ca. 0.3 mm long, forward-directed; ray cypselae elliptic-ovate in outline, to 3–4 mm diam. the body ca. 1 mm diam., each wing 1–1.5 mm diam.; disk cypselae elliptic or oblong in outline, to ca. 2–3 mm diam., all more or less resembling rays or the inner cypselae sometimes distinctly narrower than rays; pappus awns 2, 2–5 mm long, subequal, those of the rays about as long as corolla tube, those of the disks reaching past middle of corolla throat, adaxial surface flattened in plane perpendicular to that of cypselae body flattening, retrorsely barbed along the two adaxial edges as well as abaxially, barbs 0.1–0.2(–0.3) mm long, moderately close-spaced, evenly reducing in length distally.

Representative specimens. **DOMINICAN REPUBLIC**. **Azua**. Ad Las Lagunas, 1000 m, Aug 1912, *Fuertes 1897* (NY). **Barahona**. Pine woods at Aceitial, 4200 ft., 8–12 Aug 1946, *Howard & Howard 8130* (NY). [near border of **Baoruco** and **Independencia**]. Above Juan Santiago, between El Cercado [Baoruco] and Hondo Valle [Independencia], 900 m, 9 Sep 1968, *Liogier 12626* (MO, NY, P, US). **Independencia**. Sierra de Neiba, 17.3 km N of La Descubierta, 910 m, 30 May 1986, *Judd et al. 5187* (F, FLAS, NY, US). **Peravia**. entre 5–6 km S de El Pinar, 1500 ft., 22 Jul 1982, *Zanoni et al. 21967* (JBSD, MO, NY). **Pedernales**. Sierra de Bahoruco, uphill from Las Mercedes, near km 28, 940 m, 29 Jun 2006, *Pruski & Ortiz 4069* (JBSD, MO, NY, USM); Sierra de Bahoruco, km 32.5 N del puerto de Cabo Rojo, 1250 m, 10 Apr 1988, *Zanoni et al. 40759* (JBSD, MO, NY). **San Juan**. Vicinity of Río Arriba del Norte, north of San Juan, s. elev., 9–14 Sep 1946, *Howard & Howard 8965* (NY, P, US); 3 km N de la Presa de Sabaneta, 1900 ft., 24 Jun 1982, *Mejia & Pimentel 21003* (JBSD, MO, NY). **San Rafael** [not located, perhaps now in Elias Piña]. Inter Elias Piña and Calimete, s. elev., 1 Apr 1969, *Marcano et al. 5638* (NY). **HAITI**. **Artibonite**. Marmelade, 800 m, 20 Dec 1925, *Leonard 8345* (NY, US). **Nord-Ouest**. Vicinity of Bassin Bleu, Moustique Mountains, 630–1500 m, 14–27 Apr 1929, *Leonard & Leonard 14851* (NY, US), *Leonard & Leonard 14983* (MO, US). **Ouest**. Montagnes du Trou d'Eau, N of Glore, 800 m, 22 Jul 1924, *Ekman 1062* (NY, S, US); Morne à Cabrites, 500 m, 26 Apr 1942, *Holdridge 1154* (NY, US); Port-au-Prince, 1827, *Jacquemont s.n.* (P). **Port-de-Paix**. Massif du Nord, Haut-Piton, 1200 m, 22 Jul 1924, *Ekman 4629* (NY, S). **Sud**. Tiburon Peninsula, Massif de la Hotte, Morne Macaya, 1900–2150 m, 7 Jun 1984, *Skean et al. 1441* (FLAS n.v.). **Without department**: Prope La Riviere, May 1827, *Jacquemont s.n.* (P-Hennecart-2); La Brande to Mt. Balance, 2750 ft., 15 Aug 1905, *Nash & Taylor 1676* (NY); St. Domingue, *Poiteau s.n.* (P-Drake). **WEST INDIES**: Antill., *Richard s.n.* (P-Drake). **CULTIVATED IN EUROPE**. From seed collected in "Sancto-Domingo" and communicated to de Candolle (1836) by *Adolphe Brongniart s.n.* (G-DC, IDC microfiche 800 card 965.III.8, photograph MO); spec. cult. in calv. Hort. Paris, from type stock, *Anon.* (K p.p., a single branchlet about 10 cm long, mounted below packet of possible isotype); H.P. (Serr. ch.), Dec 1833, *Anon.* (P-Adrien Jussieu); Hort. Paris, 1840, *Anon.* (P-Spach); Hort. Paris, 1863, *Anon.* (P-Delacour); H.P., 1845, *Jamus s.n.* (P); Hort. Paris, 1847, *Spach s.n.* (P-Sch-Bip). **PROVENANCE UNKNOWN**: MO-2094421 ex herb. Bernhardi, possibly cultivated in Europe pre-1840.

Figure 9. *Narvalina domingensis*. SEM micrographs and photograph of cypselae, pappus awns, and corollas. A. Ray cypsela showing lateral wings about as broad as body. B. Ray cypsela awns close-up showing retrorse barbs. C. Disk cypsela showing on left incurved lateral wing. D. Three disk florets and cypselae (left), two ray cypselae (center), and two pistillate pre-fruiting ray florets (left); the stramineous-brownish lateral wings are about as broad as the black bodies; the two ray florets on right show the short corolla limbs. All from *Pruski & Ortiz 4069*, MO; scale bar D is 10 mm.

Distribution and ecology. *Narvalina domingensis* occurs mostly from 350–1500 meters in elevation in pastures, dry thickets, and open pine forests in central and western Hispaniola, both in Haiti and the Dominican Republic. The species appears to flower most frequently or at least to have been collected mostly between February and September. I have seen *N. domingensis* and *Selleophytum buchii* growing side-by-side. *Narvalina domingensis* has been especially well-collected in Massif du Nord in Haiti and in the Sierra de Bahoruco in the southwestern Dominican Republic; it does not appear to be as common in the Cordillera Central of the Dominican Republic. I have seen no collections from the eastern third of the Dominican Republic. There are several collections of cultivated material from the Paris garden made over more than a twenty year time span in the 1800s.

Typification. I do not know with certainty whether P or FI-W houses the holotype of *Needhamia domingensis* Cass., although strict reading of the Cassini (1825a) protologue suggests the type collected by Nectoux is in P. Examples for purposes of discussion of representative type citations from protologues of some West Indian Compositae include the following. Similar-leaved (albeit trinerved, not pinnate) earlier-described *Verbesina ilicifolia* Poir. 1808 (a synonym of *Wedelia serrata* L.C. Rich. 1807) was given as a Nectoux sheet "in herb. Desf." I have seen a photograph of this Nectoux sheet in FI-W, so it is clear that the Webb herbarium in FI-W has at least some Nectoux

material. The protologues of *Andromachia poiteaui* Cass., *Chthonia leptocephala* Cass., and *Lepidaploa buxifolia* Cass. each gave their respective types as "dans l'herbier de M. Desfontaines. I have seen a photograph of FI-W holotype of the *Andromachia* (now recognized as *Liabum poiteaui* (Cass.) Urb.), so it is clear that the Webb herbarium in FI-W has at least some Cassini holotypes. On the other hand, because the protologue of *Needhamia domingensis* Cassini (1825a) gave "dans l'herbier du Museum," Cassini apparently clearly distinguished the Paris museum from the private Desfontaines herbarium, and the type of *Needhamia domingensis* is presumably as cited a Nectoux collection at P, which I have not seen.

Misapplication of the name *Narvalina fruticosa*. Urban (1907) and Schulz (1911) treated West Indian endemic *N. domingensis* in synonymy of continental endemic *N. fruticosa*. This misapplication of the name *N. fruticosa* as what was once thought to be the earliest name for *N. domingensis* can be traced to Burman and Linnaeus. Plumier's (1703: 10) "*Bidens frutescens, ilicis folio, flore luteo*" was the basis of his illustration of *N. domingensis* for which Burman (1756: 42, tab. 52) used the polynomial "*Verbesina frutescens, foliis ovatis ac serratis.*" Burman (1756) also, however, added *Bidens fruticosa* L. (Linnaeus 1753) to synonymy of the Plumier plant. Linnaeus (1759, 1763) in turn also mistakenly equated Plumier's West Indian tab. 52 (in Burman 1756) and continental *Verbesina fruticosa* (based on *Bidens fruticosa*), setting into motion name misapplication not corrected for more than a century. Willdenow (1803: 2227), Persoon (1807: 472), and Poiret (1808: 461) each repeated the synonymy of Linnaeus (1759, 1763). Sprengel (1826: 602) equated Plumier's West Indian plant with continental *V. fruticosa*, albeit under the name *Pascalia baccata* (L.) Spreng. (now *Tilesia baccata* (L.) Pruski 1996). Candolle (1836: 618) in treating the vegetatively similar-to-*Narvalina* basically cpappose West Indian *Verbesina ilicifolia* Poir. (some 1800s material of *N. domingensis* was originally misdetermined as *V. ilicifolia*) suggested that both *V. fruticosa* and Plumier's illustration represented a single species. Klatt (1884: 92) cited additional misidentifications of Plumier's West Indian plant. Blake (1915) and Urban (1920, 1921) reinstated the name *N. domingensis* for our West Indian plant, and identified Plumier's plate (here reproduced from Burman 1756 as fig. 1) as *N. domingensis*. Becker (1979) recognized the Linnaean *Bidens*/*Verbesina* as the continental endemic *Lasianthaea fruticosa*, and excluded *N. domingensis* from its synonymy. Finally, Sherff and Alexander (1955), Bremer (1994), Liogier (1999), Panero (2007), and Crawford et al. (2009) each recognized *N. domingensis*.

EXCLUDED NAMES

Narvalina corazonensis Hieron., Bot. Jahrb. Syst. 29: 49. 1900 ≡ **Ericentrodea corazonensis** (Hieron.) S.F. Blake & Sherff.

Narvalina fruticosa (L.) Urb., Symb. Antill. 5: 265. 1907 ≡ *Bidens fruticosa* L. ≡ *Verbesina fruticosa* (L.) L. ≡ **Lasianthaea fruticosa** (L.) K.M. Becker.

Narvalina homogama Hieron., Bot. Jahrb. Syst. 29: 48. 1900 ≡ **Ericentrodea homogama** (Hieron.) S.F. Blake & Sherff.

Narvalina sodiroi Hieron., Bot. Jahrb. Syst. 29: 50. 1900 ≡ **Cyathomone sodiroi** (Hieron.) S.F. Blake.

ACKNOWLEDGEMENTS

I would like to thank Guy Nesom and Rosa Ortiz for helpful comments on the manuscript and Stephanie Keil and Wendy Westmoreland for their photographs of the herbarium specimens.

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Egger, J.M. 2015. New chromosome counts for selected species of North American *Castilleja* (Orobanchaceae). Phytoneuron 2015-32: 1–5. Published 27 May 2015. ISSN 2153 733X

NEW CHROMOSOME COUNTS FOR SELECTED SPECIES OF NORTH AMERICAN *CASTILLEJA* (OROBANCHACEAE)

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ABSTRACT

New chromosome counts and annotations are presented for 16 species and two additional varieties of *Castilleja* from western North America and Texas. First documented counts are reported for *C. cryptantha*, *C. elmeri*, *C. hyperborea*, *C. miniata* var. *fulva*, *C. pallida* var. *yukonis*, *C. mogollonica*, and *C. suksdorfii*.

This paper reports previously unpublished meiotic chromosome counts for selected species of *Castilleja* from western North America. These counts are based on collections made by the author, and all counts were obtained by the late T.I. Chuang and his wife, F.M. Chuang. These counts were conveyed to me, along with supporting chromosome sketches, by either L.R. Heckard or T.I. Chuang between the years 1985 and 1992, and the supporting correspondence and specimens are on file at WTU and/or UC/JEPS. They are published at this time to provide additional counts for inclusion in the *Castilleja* treatment for the Flora of North America North of Mexico. Some annotation information is also supplied. Methods used to record these counts were outlined most recently in Chuang and Heckard (1993).

Castilleja cryptantha Pennell & G.N. Jones

USA. WASHINGTON. Pierce Co.: flat, fairly lush subalpine meadow, on trail from Sunrise Visitor's Center, just before reaching Shadow Lake, Mt. Rainier National Park, 31 Jul 1988, *Egger 160*, WTU. ***n* = 12**

This is the first published count for this rare endemic of Mt. Rainier National Park and its immediate vicinity.

Castilleja cusickii Greenm.

USA. IDAHO. Caribou Co.: fairly dry pasture/meadow with little or no grazing, adjacent to U.S. Hwy 89, 1.6 km NE of bridge over Ovid Creek, northern Bear Valley, 22 Jun 1990, *Egger 322*, WTU. ***n* = 12**

This count is from an unusual population of *Castilleja cusickii* characterized by pink to violet bracts, in contrast to the typically pale yellow bracts of this species. This diploid count agrees with earlier counts for this species (Heckard & Chuang, 1977).

Castilleja elmeri Fernald

USA. WASHINGTON. Kittitas Co.: drier sites in moist meadows near Cle Elum River, along Forest Service Road 2405 just above Tucquala (Fish) Lake, Wenatchee National Forest, 9 Jul 1988, *Egger 241*, WTU. ***n* = 24**

This is the first published count for this species of mostly serpentine substrates in the central and northern Cascade Mountains of Washington and adjacent southern British Columbia.

Castilleja hyperborea Pennell

CANADA. YUKON. Dry calcareous slopes and ridges at or above timberline, about 1 km W of Dempster Hwy, 130.4 km N of junction with Klondike Hwy, 5 Jul 1991, *Egger 436*, WTU. ***n* = 12**

This is apparently the first report of a chromosome count for *Castilleja hyperborea*.

Castilleja indivisa Engelm. & A. Gray

USA. TEXAS. Johnson Co.: meadowy roadside bank, along U.S. Hwy 67, about 5 km E of Keene, between Keene and Interstate Hwy 35W, 7 Apr 1990, *Egger 314*, WTU. ***n* = 12**

This count agrees with an earlier count of this species by Heckard (1968). It should be noted that the Index to Plant Chromosome Numbers (accessed 8 May 2015) mistakenly includes counts of $n = 14$ and $n = 16$ for *Castilleja indivisa*, with an earlier paper of mine cited as the source (Egger 1994). However, in that paper I included chromosome counts only for hybrid plants involving *C. indivisa* as one of the putative parental species. Those hybrid plants showed large chromosomal irregularities (Chuang, pers. comm., 8 Jul 1990), and the counts obtained from them should not be attributed to *C. indivisa* as a single species.

Castilleja miniata Douglas ex Hook. **var. fulva** (Pennell) J.M. Egger

CANADA. BRITISH COLUMBIA. Roadside ditch, 115th Road, 3.2 km NW of junction with Canadian Hwy 29, N bluff of Peace River, 16.1 km E of Hudson's Hope, 15 Jul 1990, *Egger 378*, WTU. ***n* = ca. 48**

This collection was made in the general vicinity of the type collection of *Castilleja fulva* Pennell, the basionym of this variety. It is the first published count for var. *fulva*.

Castilleja affin. miniata Douglas ex Hook.

CANADA. ALBERTA. Lush, moist roadside field, along Canadian Hwy 2, 8.0 km E of junction with Hwy 735 to Whitelaw, Peace River region, 14 Jul 1990, *Egger 377*, WTU. ***n* = 12**

This count was made from a plant identified as *Castilleja* affin. *miniata* by Heckard in 1990. However, field work in this region has shown that the voucher is typical of what appears to be an undescribed form of *Castilleja* endemic to the Peace River region of west-central Alberta and adjacent British Columbia, Canada. Further inquiry into this entity is ongoing.

Castilleja mexicana (Hemsl.) A. Gray

USA. TEXAS. Jeff Davis Co.: fine gravelly volcanic soil on gentle slope; with low grasses and forbs, pasture on N side of Texas Hwy 17, 1.3 km SW of summit of Wild Rose Pass, NE of Fort Davis, 19 Aug 1991, *Egger 477*, WTU. ***n* = 12**

This confirms earlier counts for *Castilleja mexicana* by Chuang and Heckard (1993) and Ward (1984).

Castilleja mogollonica Pennell

USA. ARIZONA. Apache Co.: narrow band at outer edges of moist creek bottom in meadows along Hall Creek, about 0.8 km S of Arizona Hwy 273, Apache-Sitgreaves National Forest, 16 Aug 1991, *Egger 474*, WTU. ***n* = 12**

This is the first published count for this endemic of subalpine meadows in the White Mountains of east-central Arizona.

Castilleja nelsonii Eastw.

USA. ARIZONA. Apache Co.: moderately dry soil in partial shade of pine forest edges, along secondary forest road just E of Hall Creek and S of Arizona Hwy 273, Apache-Sitgreaves National Forest, 16 Aug 1991, *Egger 472*, WTU. ***n* = 12**

Castilleja nelsonii is the earliest published name for the entity long known as *Castilleja austromontana* Standley & Blumer. The present count confirms earlier chromosome counts for this species (Heckard 1968; Heckard & Chuang 1977).

Castilleja pallida (L.) Spreng. **var. caudata** (Pennell) B. Boivin

CANADA. YUKON. Dry, gravelly roadside, adjacent to the Alaska Hwy, about 12.9 km N of Burwash Landing, 3 Jul 1991, *Egger 425*, WTU. ***n* = ca. 36**

USA: ALASKA. Grassy, brushy, cleared corridor in mixed forest, pipeline corridor about 60 m down a turnoff road from Alaska Hwy, 24.6 km S of Delta Junction, 8 Jul 1991, *J.M. Egger 457*, WTU. ***n* = 36**

The first collection cited above is from a plant in the Kluane Lake region of southern Yukon, where populations of *Castilleja pallida* var. *caudata* appear to mingle with *C. pallida* var. *yukonis*. This plant did not seem to be an intermediate form, though the populations of *C. pallida* in this region merit further study to better understand the limits of both varieties. The second collection is of the form originally described as *Castilleja annua* Pennell, which I now regard as one of the many localized races of this widespread variety.

Previous reports for *Castilleja pallida* var. *caudata* include those of Johnson and Packer (1968) of $n = 48$ and Dawe and Murray (1981) of $n = 12$ and $n = 36$.

Castilleja pallida (L.) Spreng. **var. yukonis** (Pennell) J.M. Egger

CANADA. YUKON. Gravelly slope along road, N bank of Pelly River at Pelly Crossing, 2.1 km W of junction with Klondike Hwy, 7 Jul 1991, *Egger 441*, WTU. ***n* = 24**

This collection is from a location not far from the type locality of *Castilleja yukonis* Pennell, the basionym for *C. pallida* var. *yukonis,* and closely resembles the type collection morphologically. I believe it is the first count for this variety, but this is difficult to determine with certainty, due to the various names assigned to plants of the *C. pallida* complex by a variety of botanists.

Castilleja raupii Pennell

USA. ALASKA. Low brushy edges of *Salix-Picea* thickets around Denali train station and Denali Hotel, near entrance to Denali National Park, 9 Jul 1991, *Egger 449*, WTU. ***n* = 36**

This count for *Castilleja raupii* agrees with those reported earlier by Heckard (1968).

Castilleja septentrionalis Lindl.

USA. NEW HAMPSHIRE. Coos Co.: moist cliffs and rocky slopes of headwall, along trail about 2/3 up headwall of Tuckerman Ravine, Mt. Washington massif, Presidential Range, 10 Aug 1988, *Egger 246*, WTU. ***n* = 12**

The present count samples the eastern form of this widespread species, and it is in accordance with previous reports from that region (e.g.: Löve and Löve, 1982). Existing chromosome reports for this species also include plants of the Rocky Mountains region, but these were reported as the synonymous *Castilleja sulphurea* Rydberg. These reports include counts of $n = 12$, 24, and 48 (Heckard 1968; Heckard & Chuang 1977).

Castilleja suksdorfii A. Gray

USA. WASHINGTON. Skamania Co.: wet meadow with tall grass, Babyshoe Meadow, along Forest Service road to Randle, just W of road junction SW of Takhlakh Lake, Gifford Pinchot National Forest, 16 Jul 1988, *Egger 242*, WTU. ***n* = 36**

This is the first published count for *Castilleja suksdorfii*, but it also matches an as yet unpublished count for this species made from a collection by Heckard from Crater Lake National Park, Oregon, near the southern terminus of the range of this species (Heckard, pers. comm., 2 Jul 1986).

Castilleja thompsonii Pennell

USA. WASHINGTON. Skamania Co.: dry, gravelly, consolidated alpine ridges, flats, and slopes around and above "High Camp," near headwaters of Adams Creek, Mt. Adams Wilderness Area, Gifford Pinchot National Forest, 17 Jul 1988, *Egger 244*, WTU. ***n* = 12**

Previous reports for this species include $n = 12$ and $n = 24$ (Heckard & Chuang 1977). The voucher and count were obtained from the approximate type locality of *Castilleja villicaulis* Pennell & M. Ownbey, a high elevation form of *C. thompsonii* found at timberline and on the lower alpine slopes of Mt. Adams in southern Washington. While the alpine form is somewhat distinctive in its long-villous pubescence and low growth form, *C. villicaulis* is usually regarded as a synonym of *C. thompsonii*. A comprehensive review and genetic study of *C. thompsonii* is needed to determine if the Mt. Adams form in particular is worthy of varietal recognition.

Castilleja unalaschensis (Cham. & Schlt.) Malte

USA. ALASKA. Moist, shady bank along highway; near sea level, Seward Hwy, 6.9 km NW of turnoff for Girdwood, along Turnagain Arm, Seward Peninsula, 10 Jul 1991, *Egger 450*, WTU. ***n* = ca. 48**

Two previous counts for *Castilleja unalaschensis* were reported by Taylor and Mulligan (1968) as $n = 48$ and $n =$ ca.48, matching the count presented here.

ACKNOWLEDGEMENTS

I thank David Giblin (WTU) for assistance with specimens and Peter Zika for reviewing two earlier forms of the manuscript. It is also appropriate to express my deep gratitude to Peter and to the members of the Carex Working Group — Barbara Wilson, Dick Brainerd, and Nick Otting — for their invaluable assistance and support in completing the *Castilleja* treatment for the Flora of North America. I also thank the late L.R. Heckard and T.I. Chuang for providing the chromosome counts presented here and for encouragement of my developing interest in the genus *Castilleja*. It should also be noted that Dr. Chuang's wife, Fei-mei Chuang, was instrumental in determining the chromosome counts earlier published by Chuang and Heckard, as well as those presented here, and I express my sincere gratitude to her.

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CASTILLEJA COLLEGIORUM (OROBANCHACEAE), A NEW SPECIES FROM THE CASCADE MOUNTAINS OF SOUTHERN OREGON, AND THE STATUS OF *CASTILLEJA LASSENENSIS* EASTW.

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ABSTRACT

Castilleja collegiorum J.M. Egger and S. Malaby, **sp. nov.**, is described from the Cascade Mountains of southwestern Oregon (Klamath County), where it is found in seasonally wet meadows. While the new species is locally fairly common, it is a narrow endemic and its conservation status is in need of monitoring. *Castilleja collegiorum* most closely resembles *C. lemmonii* (in details of the floral morphology) and *C. cryptantha* (in the patterns of coloration in the inflorescence and in growth form). It is perhaps derived from or most closely related to *C. lemmonii*. The status of *Castilleja lassenensis* Eastw. is also discussed, and its resurrection as a distinct species is proposed, based on its consistent morphological differences and geographical disjunction from typical *C. lemmonii* in the Sierra Nevada.

The new species described here was first observed during vegetative surveys for the Winema National Forest in the 1990's (U.S. Forest Service, unpubl. data), during which it was mistaken for *Castilleja pilosa* (S. Wats.) Rydb. Subsequent visits by agency botanists overlooked it while focused on *Gentiana newberryi* A. Gray, a species with a later blooming period. In mid July 2012, Malaby visited Big Meadows looking for another rare species, *Carex capitata* L., and noticed the presence of a *Castilleja* species she had not encountered previously. While it appeared in some ways similar to *C. lemmonii* A. Gray, it differed considerably from that California endemic species, known from the Sierra Nevada and from the vicinity of Mt. Lassen, especially in coloration and in several morphological characters of the leaves, calyces, and corollas. Malaby then sent specimens of the unusual *Castilleja* to Robert Meinke (OSC), who equivocally identified them as aberrant *C. lemmonii*. Forest Service botanist Missy Anderson subsequently sent specimens and photos gathered by Malaby to Egger for further evaluation. Egger confirmed that the plants in question displayed a suite of characters clearly differentiating it from *C. lemmonii* and proposed that it might represent an undescribed species. Egger visited the site with Malaby on 25 July 2014, confirmed the novelty of the species, and obtained the type collection.

CASTILLEJA COLLEGIORUM J.M. Egger & S. Malaby, **sp. nov**. (Figs. 1-3). **TYPE: USA. Oregon.** Klamath Co.: Fremont-Winema National Forest, eastern Cascade Mountains, Big Meadows, W of Pelican Butte, T35S R5E sec 14 and 11, drier margins and hummocks of seasonally wet, loamy meadow complex, ca. 5650 ft. (ca. 1720 m), 25 Jul 2014, *M. Egger 1540 & S. Malaby* (holotype: WTU; isotypes: CAS, GH, K, MO, NY, OSC, P, RM, UC, US).

Most closely resembling to *Castilleja lemmonii* A. Gray (in details of the floral morphology) and *Castilleja cryptantha* Pennell & G.N. Jones (in the patterns of coloration in the inflorescence and in growth form) but differing from both in its consistent combination of the following characters: inflorescences slender, somewhat elongated and non-capitate, the bracts gradually and weakly

differentiated from the leaves; pale cream-white or pale greenish-yellow base coloration of the calyces and bracts, with varying infusions of dull maroon to pale reddish-violet pigments in the bracts and calyces, especially with age; main cauline leaves with a pair of divaricate-ascending, linear-lanceolate, distally acute lobes; the bracts appearing to be significantly shorter than the flowers; calyces 11–20 mm long, with short segments, 0.5–1.5 mm in length; corollas 18–25 mm long, with the beak about twice the length of the lower lip, the latter having whitish, linear-lanceolate distal teeth.

Plants perennial, branching from slender, woody, often taprooted caudices. **Stems** few to many, most plants producing 6–18 flowering stems, unbranched, short-decumbent proximally, quickly becoming upright-ascending distally, 15–28 cm long when mature, dull greenish to dull reddish, villosulous with thin, multicellular, usually minutely stipitate-glandular hairs. **Leaves** narrow, sessile, upright-ascending, 15–35 mm long, 2–13 mm wide, linear to linear-lanceolate, distally acute-tipped, pale greenish to dull reddish-maroon, sparsely villosulous with a mixture of stipitate-glandular hairs and non-glandular hairs, often entire proximally but always becoming divided and 3-lobed for at least the distal 2/3 of the stem, the spreading to ascending lateral lobes usually branching from the distal half of the blade, linear-lanceolate, acute-tipped, and usually shorter and narrower than the central lobe. **Inflorescences** narrow, often elongated, racemiform spikes, not strongly differentiated from the leaves, 4–10 cm long, 0.5–20(–25) cm wide in mid-flowering, elongating somewhat with age; flowers few to many, sessile; prominent coloration borne both on bracts and calyces, with the base color pale cream-white to pale greenish-yellow, but this often partly to entirely suffused with dull reddish-violet to maroon, especially proximally, along veins, and with age (Figs. 5-6). **Bracts** gradually and weakly differentiated from the leaves, more or less narrowly lanceolate, 10–20 mm long, 2–8 mm wide, usually appearing to be shorter than the flowers, almost always divided from above mid-blade into 3 acute-tipped lobes, the central lobe lanceolate, and the lateral lobes linear-lanceolate and shorter; pubescent with a fairly dense indument of villosulous hairs, some of which are minutely stipitate-glandular; base coloration pale cream to pale greenish-yellow, but this often partly to entirely suffused with dull reddish-violet to dull maroon, especially proximally, along veins, and with age. **Calyces** 11–20 mm long, divided adaxially and abaxially into two subequal primary lobes 7–12 mm in length, each of these distally shallowly cleft into two triangular, acute to obtuse segments, each 0.5–1.5 mm in length; usually pale greenish proximally becoming whitish on the distal segments, sometimes reddish-violet to maroon distally and/or with a thin vertical stripe of pale reddish-violet; minutely puberulent with mostly non-glandular hairs. **Corollas** 18–25 mm long; subglabrous to minutely puberulent; beaks 6–7 mm long, adaxial surface pale greenish to pale cream with the thin margins unpigmented or sometimes with a faint blush of pale reddish; lower lip about 3 mm long, consisting of three fused, longitudinally grooved and bilobed, uninflated, greenish pouches, about 2 mm long, from each of which emerges a linear-lanceolate, slightly incurved, white tooth, about 1 mm in length. **Stigmas** barely exserted from the calyces, subcapitate to minutely bilobed, greenish. **Anthers** mostly included within and dehising from the thin margins of the corolla beak, filaments glabrous. **Capsules** 7–10 mm long, 3–4 mm wide, narrowly ellipsoid with a slightly curved, acuminate tip, medium brown, glabrous. **Seeds** 20–30 per capsule, 1–2 mm long, ovoid, pale white; coat loose-fitting, very shallowly reticulate, cells mostly polygonal-ovate; radial walls membranous, smooth and unstriated; inner tangential walls membranous and ruptured to less commonly unruptured at maturity.

Castilleja collegiorum is named in celebration of the modern collaboration of botanists of many standings in the advancement of the science to which we all are dedicated, incorporating the knowledge and contributions of amateurs, field botanists, agency personnel, collections managers, and professional botanists alike.

Additional specimen examined. USA. Oregon: Klamath Co.: Fremont-Winema National Forest, Klamath Ranger District, Cascade Mountains, Big Meadows, 5650 ft, 15 Jul 2013, *S. Malaby s.n.* (WTU).

Figure 1. *Castilleja collegiorum* in the field, Big Meadows, Klamath Co., Oregon, 15 Jul 2013. All photos of *C. collegiorum* in the field by Sarah Malaby.

HERBARIUM OF
UNIVERSITY OF WASHINGTON
WTU-V-1311
HOLOTYPE! of:
Castilleja collegiorum J.M. Egger & S. Malaby
Determined by Mark Egger, 2003-2004
University of Washington
Castilleja *collegiorum, sp. nov.* J.M. Egger & S. Malaby
var. ssp.
Family Orobanchaceae 25 Jul 2014
Location Around forested "island" within and along margins of Big Meadow, via Cold Springs Trl road 3631, W on forest road 3659, N on 080 spur to meadow, Klamath Ranger District, eastern Cascade Mountains, T26S, R9E.Sec.23, SE1/4 of NW1/4
Jurisdiction Fremont-Winema National Forest County Klamath
State OR Country Elevation 5650'
Habitat Patchy distribution, generally in a narrow band above wet sedge/hairgrass community up to forested edge of meadow.
Color Culyces pale white to yellowish-green; bracts mostly dull reddish-brown
Notes HOLOTYPE; locally common
J. M Egger & S. Malaby 1540 Distribution WTU Photo? y

Figure 2. Holotype of *Castilleja collegiorum*, WTU.

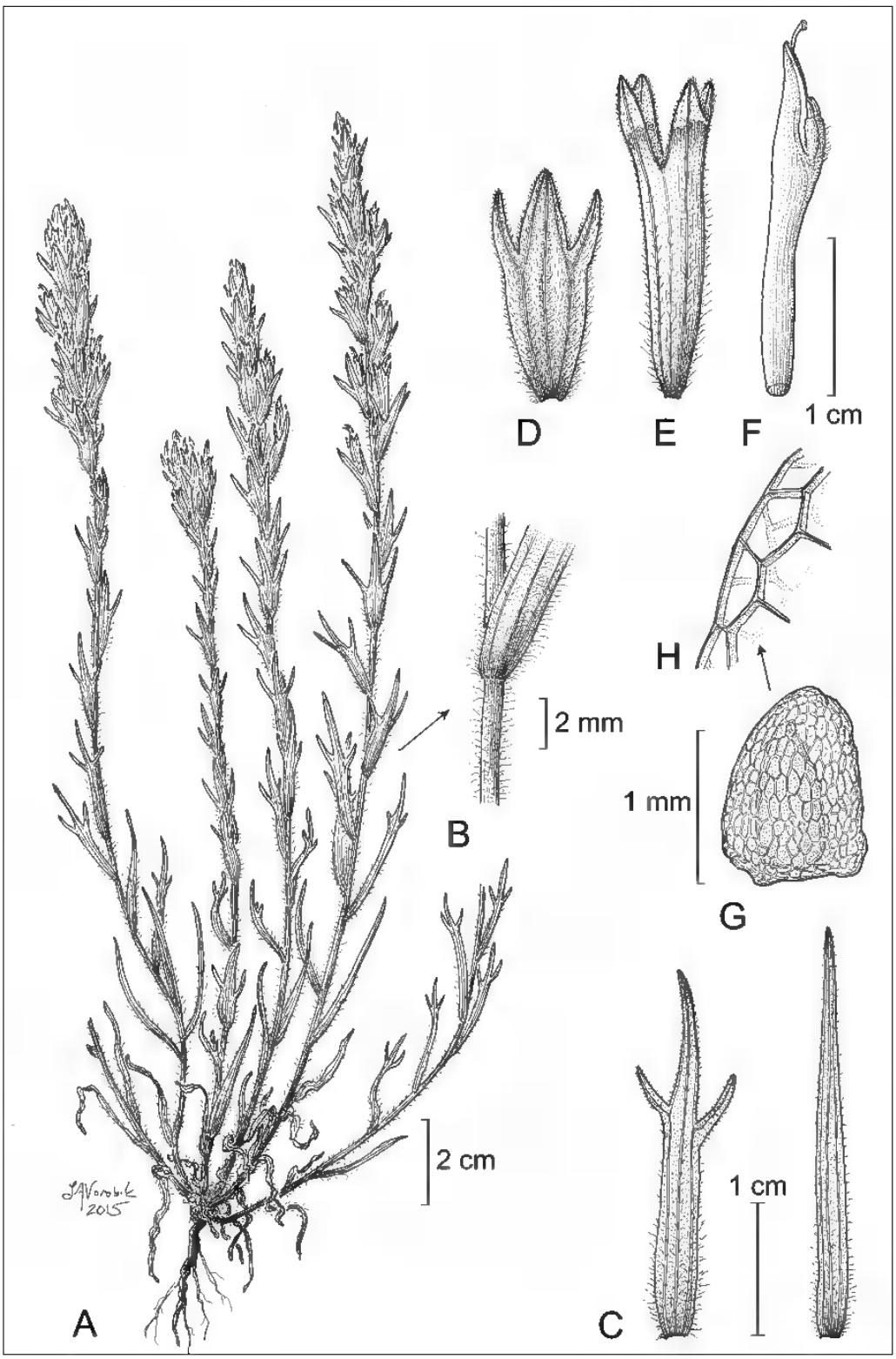

Figure 3. *Castilleja collegiorum*, based on the holotype. A. Habit. B. Close-up of stem. C. Leaves. D. Flower bract. E. Calyx. F. Corolla. G. Seed. H. Close-up of seed coat. Illustration by Linda Ann Vorobik, 2015.

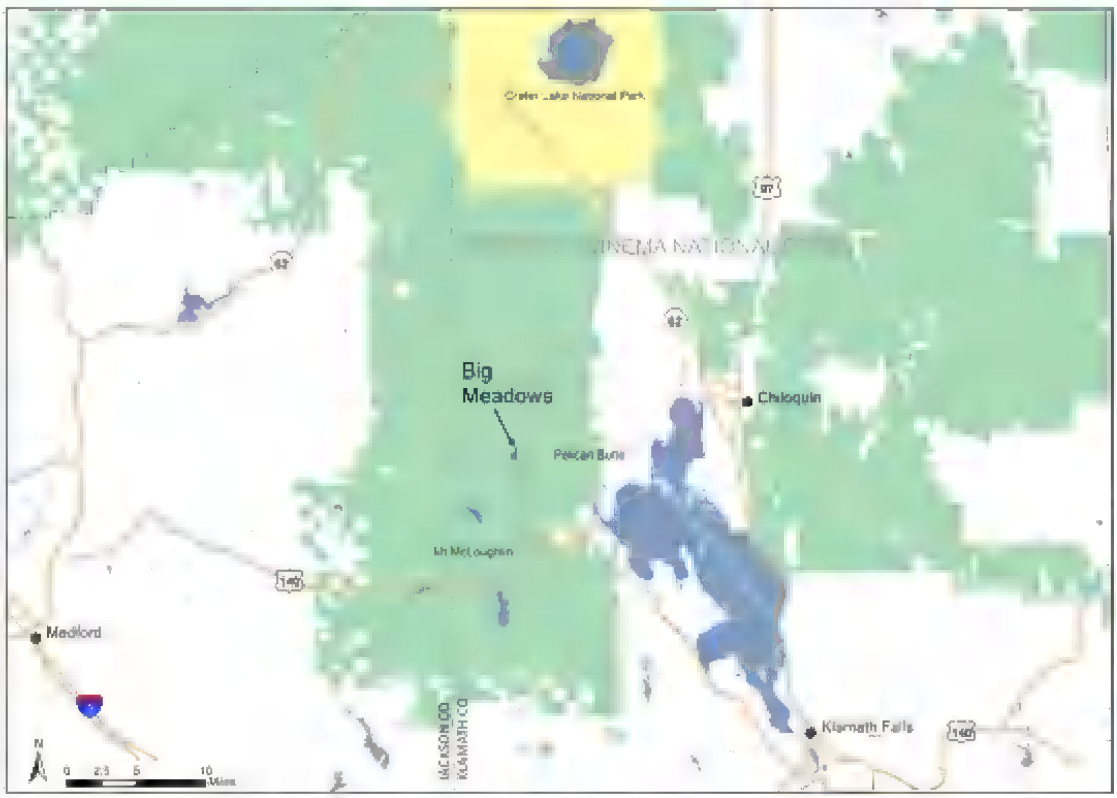

Figure 4. Location of Big Meadows population of *Castilleja collegiorum* in southwestern Oregon.

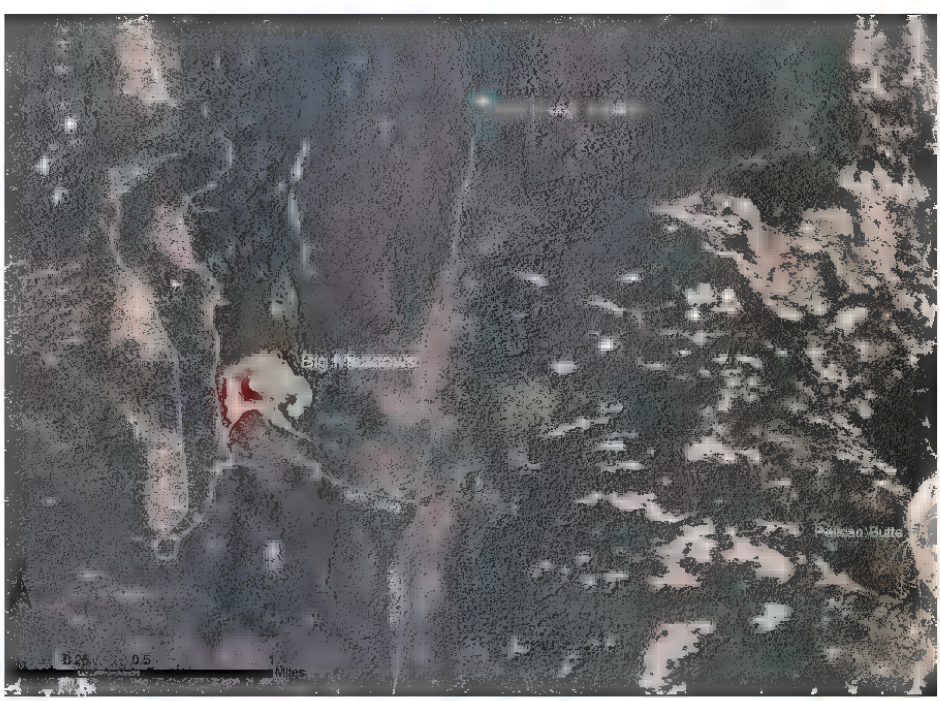

Figure 5. Aerial photo showing mapped occurrences of *Castilleja collegiorum*, marked in red, within the Big Meadows complex.

Distribution and range

Castilleja collegiorum is presently known from a single population complex at Big Meadows, a meadow system within a forest of lodgepole pine (*Pinus contorta*) consisting of slightly to highly mesic components. Big Meadows is located in the Cascade Mountains of southwestern Oregon at approximately 1725 meters (5660 ft) elevation within the Lost Creek drainage (Figs. 4-5). While searches of additional wet meadow sites in local area have not yielded additional populations, it is possible that additional surveys may reveal their presence.

Ecology, associated species, and phenology

Castilleja collegiorum occurs along the drier but still mesic edges and on slightly raised areas in wet meadows dominated by herbaceous plants (Figs. 6-8). Soils are classified as fine-loamy Humic Cryaquepts, which are deep and poorly drained, with up to 8 cm of organic material over an A horizon consisting of very dark brown mucky diatomaceous silt (Dorr et al. 2008). The meadow is dominated by tufted hairgrass, sedges, and rushes (see species list below), but in areas where *C. collegiorum* is found, there is a diversity of low-growing forb species and scattered *Vaccinium uliginosum*. *Pinus contorta* forest surrounds the meadow. Associated species include *Potentilla breweri*, *Oreostemma alpigenum* var. *andersonii*, *Deschampsia cespitosa*, *Muhlenbergia filiformis*, *Danthonia californica*, *Danthonia intermedia*, *Erythranthe primuloides*, *Pedicularis attollens*, *Polygonum bistortoides*, *Vaccinium uliginosum*, *Trifolium longipes*, *Gentiana newberryi*, *Ranunculus alismifolius*, *Carex nebrascensis*, *Carex capitata*, *Carex simulata*, *Carex pachystachya*, *Carex buxbaumii*, *Juncus balticus*, *Carex luzulina*, and *Pyrrocoma sp.*

Castilleja collegiorum has been observed in flower from 6 July to 26 July. The timing and duration of flowering likely vary annually depending on the depth and persistence of the snowpack and the amount of ponding in the meadows. No potential pollinators, either avian or insect, were noted visiting the flowers of *C. collegiorum* in the field, and we observed little if any evidence of predation on the plants by animals of any sort.

Figure 6. Habitat of *Castilleja collegiorum*, Big Meadows, 15 Jul 2013. The silvery-leaved plant is *Potentilla breweri*, a frequent associate of *C. collegiorum*.

Figure 7. Habitat of *Castilleja collegiorum*, Big Meadows, 15 Jul 2013. Plants occur mostly in left side of the photo, between the trees on the left and the lower, wetter ground on the right.

Conservation status

Castilleja collegiorum appears to have a very limited range and a patchy distribution. However, in sites where its precise habitat requirements are met, plants can be quite densely populated. The current population estimate is roughly 20,000 plants occupying approximately three acres. The known population is located in the Pelican Butte Semiprimitive Recreation Management Area. This area is not presently grazed by livestock and is closed to off-road, wheeled, motorized vehicles. Relatively low levels of dispersed recreation such as snowmobiling, hunting, and camping are its primary uses.

Because *Castilleja collegiorum* appears to have specific hydrologic requirements, long-term droughts and other effects associated with global and regional climate change may adversely affect this species. Future changes in land use management are not anticipated, but increased recreational use or disturbance from off-road vehicles could potentially result in adverse effects on this species. In July 2014, we observed tire tracks and ruts within a portion of the largest meadow, including areas occupied by *C. collegiorum*. For the present, *C. collegiorum* should be considered a range-restricted endemic and managed as a sensitive species, as currently defined by the U.S.D.A. Forest Service rare plant management regulations. Further study of the new species, particularly its range, genetics, and population trends, is recommended. Additional surveys in this portion of the Cascade Mountains should be made at the appropriate season.

Figure 8. Habitat of *Castilleja collegiorum* at Big Meadows, with *Potentilla breweri*, 15 Jul 2013.

Relationships and identification and the status of *Castilleja lassenensis*

With its combination of pale coloration, very short calyx segments, and relatively short corolla beak, *Castilleja collegiorum* is readily placed in sect. *Pallescentes*, as defined most recently by Chuang and Heckard (1991). With its soft pubescence and preference for mesic meadow habitats, it can be further placed within the Chrysanthae, an informal species assemblage utilized by Ownbey (1959) and others. Within that assemblage, *C. collegiorum* most closely resembles *C. lemmonii* in details of the floral morphology and *C. cryptantha* in the patterns of coloration in the inflorescence and in growth form (Figs. 9-10). It seems most likely that *C. collegiorum* is derived from *C.*

lemmonii, both because of the morphological congruencies and the relatively short disjunction between *C. collegiorum* and the nearest known populations of *C. lemmonii*-like plants (see discussion below) in the subalpine meadows surrounding Mt. Lassen in northwestern California, about 220 km to the south. *Castilleja lemmonii* is not known to occur in Oregon. Occasional specimens of *C. lemmonii* are pale-bracted, but most of these variants are pure white or pinkish in coloration and occur as aberrant individuals within larger populations of typically colored plants. In contrast, *C. collegiorum* is very constant in its characters and is easily distinguished by its coloration and morphology and by its more northern range.

The populations of *Castilleja lemmonii*-like plants found in the vicinity of Mt. Lassen represent a unique, disjunct form originally described as *Castilleja lassenensis* Eastw. (Eastwood 1940) (Fig. 10-11). In subsequent years, regional floras have usually placed this name as a synonym of *C. lemmonii*, though it was treated as a full species as recently as the early 1960's (Gillett et. al, 1961). During the examination of specimens in the field and herbarium and photographs of the Mt. Lassen plants for this study, it became evident that these plants have consistent and visually striking differences from the Sierra Nevada populations of *C. lemmonii* and that these differences, together with the disjunct nature of their populations (beyond the northwestern extremity of the range of typical *C. lemmonii*), warrant their formal taxonomic recognition. Recognition of *C. lassenensis* as conspecific with *C. lemmonii* can be seen as emphasizing the probable parent-derivative relationship and the quantitatively low morphometric distinction of *C. lassenensis*, but species vary widely in the nature of their origin and in their degrees of distinction. We treat *C. lassenensis* at specific rank and have included it in the key presented below.

Castilleja lassenensis Eastw., Leafl. W. Bot. 2: 244. 1940. **TYPE**: **USA. California**. [Shasta Co.:] On the trail to Bumpas Hell, Mt. Lassen, alt. 7000 ft., 7 Sep 1931, *M.S. Jussel s.n.* (holotype: CAS!).

Castilleja collegiorum has been confused with *C. pilosa* and *C. lemmonii*. It is also similar in coloration and overall aspect to *C. cryptantha*, a rare species known only from the vicinity of Mt. Rainier in the Cascade Mountains of Washington. However, *C. collegiorum* is easily distinguished from those species using the key below. Also included in the key are the following species that occur in southwestern Oregon and adjacent northwestern California that might reasonably be confused with *C. collegiorum*: *C. arachnoidea* A. Gray, *C. attenuata* (A. Gray) Chuang & Heckard, *C. chlorotica* Piper, *C. lacera* (Benth.) Chuang & Heckard, *C. lassenensis*, and *C. tenuis* (A. Heller) Chuang & Heckard.

1. Calyces cleft more or less equally into four subequal lobes; all species annual except *C. arachnoidea* and *C. pilosa* ..... **Castilleja arachnoidea**, **C. attenuata**, **C. lacera**, **C. pilosa**, **C. tenuis**
1. Calyces cleft much more deeply in the abaxial/adaxial direction than laterally; plants perennial from a woody caudex.

2. Leaves of plants with crisped margins; lower lip of corollas expanded, corolla beak prominently curved in the abaxial direction, the expanded margins of which are often reddish and prominent; plants of more xeric substrates ..... **Castilleja chlorotica**
2. Leaves of plants with mostly smooth margins; lower lip of corollas not expanded, corolla beak more or less straight or only very slightly curved in the abaxial direction; plants of seasonally mesic substrates.

3. Inflorescences almost always pink-purple to magenta, occasionally white, noticeably wider than and strongly differentiated from the leafy stem, appearing more or less capitate; cauline leaves mostly entire, though often 3-lobed distally, below the inflorescence; segments of calyces longer, 1.5-3 mm in length; endemic to either Mt. Lassen or to the Sierra Nevada, California and adjacent Nevada.

4. Beak and tube of corollas entirely clear white or white with very pale salmon margins on the beak; lower lip pale green to yellow-green, with white distal teeth; stigmas pale green; proximal 1/2 of calyces pale green, becoming violet-purple only on the distal 1/2; plants endemic to subalpine meadows with volcanic substrates on the flanks of Mt. Lassen .... **Castilleja lassenensis**

4. Beak and tube of corollas greenish on the upper surface with blood red margins on the beak; lower lip greenish with violet-purple distal teeth; stigmas greenish to dark bluish-purple; calyces usually at least pale violet-purple throughout; plants widespread in subalpine meadows with primarily granitic substrates in the Sierra Nevada of California and adjacent Nevada ..... **Castilleja lemmonii**

3. Inflorescences pale cream-white to pale greenish with variable infusions of dull maroon on the bracts and less commonly on the calyces, only slightly wider than and only weakly differentiated from the leafy stem, appearing more elongate and not at all capitate; cauline leaves usually divided into three acute lobes, at least on the distal 2/3 of the stem; segments of calyces shorter, about 1.5 mm or less in length; not found in California.

5. Beak and lower lip of corollas essentially subequal, with the beak exceeding the lower lip by no more than 1 mm; corolla usually included within the calyces and not visible; bracts appearing to be longer than the flowers; leaves larger and broadly lanceolate; plants at least partially self-pollinating; endemic to subalpine meadows on and closely adjacent to Mt. Rainier, Washington ..... **Castilleja cryptantha**

5. Beak of corollas about twice the length of the lower lip; corolla beaks and lower lips often exserted above the calyces, and/or primary calyx lobes spreading to reveal the distal portions of the corolla; bracts appearing to be shorter than the flowers; leaves narrower and linear-lanceolate; pollination system unknown but likely cross-pollinated by bees; endemic to Big Meadows, Klamath Co., Oregon ..... **Castilleja collegiorum**

Figure 9. *Castilleja collegiorum* (left) at Big Meadows, 15 Jul 2013, and *Castilleja cryptantha* (right) at Berkeley Park, Mt. Rainier National Park, Pierce Co., Washington, 23 Aug 1993. Photo of *C. cryptantha* by Mark Egger.

Figure 10. *Castilleja lassenensis* (left), Emerald Lake, Mt. Lassen National Park, Shasta Co., California, 11 Jul 1997, and *C. lemmonii*, Sierra Nevada form (right), Tuolumne Meadows, Yosemite National Park, Tuolumne Co., California, 7 Aug 1993. Photos by Mark Egger.

Figure 11. *Castilleja lassenensis*, Kings Creek Picnic Area, Mt. Lassen National Park, Shasta Co., California, 12 Aug 2004 (left) and 23 Jul 2014 (right). Photos by Dee Warenycia.

ACKNOWLEDGEMENTS

Discussions with James L. Reveal shortly before his untimely death led to the selection of the species name. This paper is dedicated to his memory. Linda Vorobik prepared the fine illustration of the new species. Missy Anderson (Winema-Fremont National Forest) provided logistical support, and Jeannette Wilson arranged for financial support from the Forest Service for the preparation of the illustration. Thanks to Dee Warenycia for use of her photos of *C. lassenensis*. Useful comments on the manuscript were kindly provided by Guy Nesom and Peter Zika (WTU). Finally, we thank David Giblin (WTU) for assistance with specimens and Maria Yousoufian (WTU) for imaging the holotype specimen.

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NEEDED LECTOTYPIFICATIONS IN *PANICUM* (POACEAE) AND A FEW OBSERVATIONS OF ANOTHER ERA

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ABSTRACT

During an examination of *Panicum* sensu lato at herbarium NCU, it was determined that 9 published *Panicum* names were in need of lectotypification: *Panicum arenicola* Ashe, *P. commelinifolium* Ashe, *P. filiculme* Ashe, *P. filiramum* Ashe, *P. georgianum* Ashe, *P. microphyllum* Ashe, *P. nemopanthum* Ashe, *P. onslowense* Ashe, and *P. subvillosum* Ashe. For the majority, the original type is missing, but types were never designated for *P. filiculme* and *P. microphyllum*. The needed lectotypifications are designated here.

Nine *Panicum* names needing lectotypification (Table 1) were found during a 2011-2014 examination of the *Panicum* sensu lato collection at the University of North Carolina-Chapel Hill (NCU). Lectotypification is the designation of a specimen as the substitute for a holotype by a later worker when the nomenclatorial author either failed to designate a valid specimen as holotype or when the designated holotype is missing. Lectotypification is also required when a previously designated lectotype is missing. All 9 names were originally published between 1898 and 1901 by W.W. Ashe and were treated by Hitchcock and Chase (1910). That 1910 treatment remains the authority for typification of most North American *Panicum* names from that era.

Table 1. Nine *Panicum* names needing lectotypification.

name	**reason for lectotypification**
Panicum arenicola	original lectotype missing; subsequent invalid lectotypification
Panicum commelinifolium	holotype missing
Panicum filiculme	type never designated; subsequent invalid lectotypification
Panicum filiramum	holotype missing
Panicum georgianum	holotype missing; subsequent invalid lectotypification
Panicum microphyllum	type never designated; subsequent invalid citing of specimen as isolectotype
Panicum nemopanthum	"co-type" was designated, but type wasn't seen and remains missing
Panicum onslowense	holotype missing; subsequent invalid lectotypification
Panicum subvillosum	holotype missing; subsequent invalid citing of another specimen as holotype

There is a concentration of *Panicum* nomenclatural literature from the work of George Vasey (1889) to the treatment by A.S. Hitchcock and Agnes Chase in 1910. The Hitchcock & Chase volume has often been cited for its remarkably comprehensive and coherent treatment of the massive *Panicum* complex. But it is also remarkable for its use of the type concept, which had only been codified three years before (Nomenclatural Commission 1907). Hitchcock and Chase attempted to locate and verify a type specimen for every name, including synonyms, in their 1910 treatment. This effort formed a significant part of the publication and was one of the earliest uses of the process now called lectotypification.

Type determinations in the recent NCU examination required searches of the older literature and online databases, as well as examination of type specimens in other herbaria (usually online, but sometimes on loan). The Missouri Botanical Garden's Tropicos database (Tropicos 2015) provided a basis for nomenclatorial authority and type specimen locations. Biodiversity Heritage Library (BHL 2015) provided access to several of the nomenclatural protologues published during the particularly active period of *Panicum* field work and taxonomy in the late 19th and early 20th centuries.

Identification of types in that era was complicated not only by inconsistent historical application but also by the nonstandardized documentation of collection data and specimen labeling. Specimen and/or sheet numbering by collectors were particularly troubling. Hitchcock & Chase noted that "It not infrequently occurs that two or more species, collected at the same time and place, or collected at different times and places but supposed by the collector to be the same species, are distributed under the same number to different herbaria." Dates of collection were also nonstandarized. Some collectors — including Ashe, G.V. Nash, and J.K. Small — used the inclusive dates of the field expedition as the date on the label. For example, Ashe indicated "June 10 – July 6, 1898" as the dates for an expedition that included the type collections of *Panicum glabrissimum, P. lucidum, P. mattamuskeetense,* and *P. roanokense*, all subsequently named by him. Sometimes Ashe just recorded the month of collection, without the year, indicating the date to him was only important phenologically.

All 9 names in this treatment were authored by Ashe. This is not surprising given that the specimens from his herbarium are housed at NCU and contributed to the discovery of some of the needed lectotypifications. Also, Ashe authored more *Panicum* names than anyone, 48. Nash was the second most prolific *Panicum* author, with 44 names.

During this era many new names were published, far more than are currently recognized. This was due in part to the disparity between those who worked in the field, many of whom were amateurs, and those who worked in the herbarium. It was common for field botanists to have limited access to herbaria and botanical libraries. "On the other hand," wrote Gleason (1952), "the professional botanists often had little field experience with the plants which they studied. Careful study of plants in this country by competent men both in the field and in the herbarium is scarcely more than 50 years old."

Since 2001, the International Code of Nomenclature for algae, fungi, and plants (McNeil et al. 2012) requires that a lectotypification be explicity designated when published. The designation must include a statement such as "lectotype designated here," so that the intent is clear. The designation must also clearly apply to a particular specimen. The lectotype must be chosen from material matching the taxonomic description in the protologue and known to have been original material studied by the author. The priority specimen for selection is a duplicate (isotype or isolectotype) of the cited type specimen (holotype or lectotype), followed by a syntype, then by a paratype. If none of these is available, then selection is made from original material known to have been studied by the author or from illustrations of such material. (Absent all of these, a neotype must be designated.)

During the examination of the NCU *Panicum* collection, many type specimens previously unknown from the collection were identified. Due to the complexities of determinations and verifications, a data format was created to maintain order and to assist subsequent workers who need to follow these paths. A subsequent paper will treat the newly found type specimens, and its data format is used here.

The format begins with the currently accepted form of the name and its publication details, plus any other spelling forms of the specific epithet and where they appeared. This is followed by the typification data in the original protologue, determination of type specimens by Hitchcock and Chase, the classification of all known type specimens (including designation of the new lectotypifications), typification commentary, Hitchcock and Chase taxonomic treatment, and current taxonomic treatment in Freckmann & Lelong (2003) and LeBlond (2015).

When examining older *Panicum* types, it is important to go to the protologue. The author often cites multiple collections as representing his concept of the named entity, which today are usually called paratypes or syntypes. Hitchcock and Chase frequently omitted references to any additional collections in the protologue after the first. If more than one collection was cited, they mechanically chose the first mentioned as the type (as long as a specimen was available), following the newly-published code. Their concern was only with the establishment of a type specimen along with verification of other specimens from the same collection. The concepts of "holotype" and "lectotype" had not yet been developed, and the Hitchcock & Chase designations were often ambiguous relative to the current use of those terms. Hitchcock and Chase usually provided a brief description of the mounted material on the specimen sheet they determined to be the type, which has proven to be of great benefit.

This treatment employs the terms "topotype" and "topolectotype" for some specimens in the type classification section. These are specimens collected from the same site as the holotype or lectotype at an earlier or later date than the original type collection; the collections need not have been made by the original type collector. Although not formally recognized by the International Code of Nomenclature (McNeil et al. 2012), they are frequently used in taxonomic literature. They deserve formal recognition as they almost always are more closely related genetically to holotypes and lectotypes and to their isotypes and isolectotypes, than are syntypes and paratypes, which were collected at other sites.

Unless otherwise stated, label data are from the holotype or lectotype. A backslash, / , with a space on either side, is used to indicate data breaks in the label data where needed for clarity. Collectors' names are not italicized unless that is how they are represented on the label. Distinction is made between printed and handwritten data only when necessary, but all capitalized data were printed as such.

1. PANICUM ARENICOLA Ashe, J. Elisha Mitchell Sci. Soc. 15: 56. 1898. Name spelled *P. arenicolum* in protologue, and *P. arenaecolum* on some sheets.

Protologue typification. "Type material collected by the writer at Chapel Hill, N.C. June 1898, and later at several localities in the eastern portion of the same state" (Ashe 1898, p. 56).

Type specimen determination by Hitchcock & Chase (1910, p. 166). "The type could not be found in Ashe's herbarium. In Hitchcock's herbarium is a specimen labeled '*Panicum arenaecolum* Ashe' collected in the vicinity of Chapel Hill, North Carolina, by W.W. Ashe, and sent by him to Professor Scribner. The date of collection is not given. This specimen, which is probably a duplicate type, consists of two vernal culms, somewhat appressed-pubescent below; the stiffly ascending blades are glabrous except the lowermost, which is sparsely pubescent beneath."

Types. LECTOTYPE (designated here): NCU 20397. **ISOLECTOTYPES:** MO 1837598; NY 381579, 381580. Label data: "PLANTS OF THE SOUTHERN UNITED STATES IN THE VICINITY OF CHAPEL HILL, NORTH CAROLINA / *P. arenaecolum* Ashe / June / W.W. Ashe, Collector."

Typification commentary. Subsequent workers identified the type specimens at MO and NY as isotypes, apparently based on the then-missing type in Ashe's herbarium. Gould and Clark (1978) included the following in synonymy with *Dichanthelium aciculare* Desv. ex Poir.: "*P. arenicolum* Ashe, 1898. Lectotype, US; isolectotypes, NY." There are no known types for this name at US, so the "Lectotype, US" must refer to the specimen from "Hitchcock's herbarium" described by Hitchcock & Chase. However, the location of that specimen is unknown and another specimen has to be chosen as the lectotype.

A specimen from the Ashe herbarium matching the protologue was found at NCU (no. 20397) during the current examination. It could well be the missing type referenced by Hitchcock & Chase, but lacks a type designation by Ashe on the sheet. It is selected as the lectotype.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum aciculare* Desv. ex Poir.

Current treatment. *Panicum aciculare* is the basionym of *Dichanthelium aciculare* (Desv. ex Poir.) Gould & C.A. Clark (Freckmann & Lelong 2003; LeBlond 2015).

2. PANICUM COMMELINIFOLIUM Ashe, J. Elisha Mitchell Sci. Soc. 15: 29. 1898, nom. illeg. hom., not Rudge, 1805. Name spelled *P. commelinaefolium* in protologue and in Hitchcock & Chase 1910. This nom. illeg. was later replaced by *P. curranii* Ashe, J. Elisha Mitchell Sci. Soc. 15: 113. 1899.

Protologue typification. "Based on material collected by Dr. J.K. Small near Stone Mt., Ga., Aug. 1-6, 1895, and distributed as *P. commutatum*" (Ashe 1898, p. 29).

Type specimen determination by Hitchcock & Chase (1910, p. 304). "The type, in the Biltmore Herbarium, consists of several late vernal culms beginning to branch, with short internodes and short-exserted panicles. The culms, sheaths, and both surfaces of the blades are puberulent, the blades 1.7 to 2.5 cm. wide, the spikelets 2.8 mm. long."

Types. LECTOTYPE (designated here): US 80590 (fragm., photo of holotype). **ISOLECTOTYPES:** NCU 17318; NY 413967; US 2478905, 2478926. Lectotype label data (on packet of fragment from holotype): "*Panicum commelinaefolium* Ashe / Stone Mountain Ga. / coll John K Small, Aug 1-6, 1895 / (from Biltmore Herb)."

Typification commentary. The location of the type seen by Hitchcock & Chase is currently unknown. US 80590, formerly treated as an isotype, contains a small fragment of material and a photograph of the Biltmore type. It is selected as the lectotype.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum commutatum* Schult.

Current treatment. *Panicum commutatum* is the basionym of *Dichanthelium commutatum* (Schult.) Gould (Freckmann & Lelong 2003; LeBlond 2015).

3. PANICUM FILICULME Ashe, J. Elisha Mitchell Sci. Soc. 15: 59-60. 1898, nom. illeg. hom., not Hackel ex Schinz, 1895.

Protologue typification. "Dry soil, middle North Carolina to Georgia in the Piedmont plateau region. ... North Carolina: Ashe; Chapel Hill, 1898. Georgia: Small; Stone Mt., Aug. 1895" (Ashe 1898, p. 60).

Type specimen determination by Hitchcock & Chase (1910, p. 210). "The type could not be found in Ashe's herbarium. In the National Herbarium is a specimen from Stone Mountain, Georgia, collected by Ashe, which answers to the description. The culms are erect, slender, 12 to 20 cm. high, with small panicles about 2 cm long. The culms are the early autumnal form with a few erect fascicles of secondary branches. This specimen differs somewhat in aspect from the type of *P. meridionale*, but they are forms of the same species."

Types. LECTOTYPE (designated here): NCU 18291. Label data: "GEORGIA PLANTS / COLLECTED ON AND ABOUT STONE MOUNTAIN, DEKALB COUNTY / JOHN K. SMALL, AUGUST 1-6, 1895 / ALTITUDE 1000-1500 FEET."

Typification commentary. NCU 18291 is from Ashe's herbarium. No taxonomic name was entered on Small's label, but the specimen matches the protologue date, location, collector, and description for *P. filiculme*.

Hitchcock & Chase apparently never saw a type specimen for this name. The specimen collected by Ashe (not Small) from Stone Mountain, and referenced by Hitchcock & Chase, was erroneously considered to be the lectotype by Lelong (1984) and Hansen & Wunderlin (1988). But it should be noted that "W.W. Ashe, Collector" on the label is printed, along with "PLANTS OF THE SOUTHERN UNITED STATES." It is possible that Ashe, who annotated this specimen on the label as "*Panicum filiculme* Ashe," carelessly used his own label for a Small specimen.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum meridionale* Ashe.

Current treatment. *Panicum meridionale* is the basionym of *Dichanthelium merdionale* (Ashe) Freckmann (LeBlond 2015), and synonym of *D. acuminatum* (Sw.) Gould & C.A. Clark subsp. *implicatum* (Scribn.) Freckmann & Lelong (Freckmann & Lelong 2003).

4. PANICUM FILIRAMUM Ashe, J. Elisha Mitchell Sci. Soc. 16: 88. 1900. *Panicum* "*filirameum*" is the common spelling, but "*filiramum*," the spelling in the protologue, has been determined to be valid (K. Gandhi, pers. comm., 12 Feb 2013).

Protologue typification. "Habitat: sandy woods, eastern North Carolina. Type material collected in New Hanover county, N.C., in June 1899" (Ashe 1900, p. 89).

Type specimen determination by Hitchcock & Chase (1910, pp. 166-167). "The type, in Ashe's herbarium, consists of two single vernal plants, with slender, villous culms, sheaths less villous, blades nearly glabrous on one plant, sparsely long-pilose on the other, the panicles overmature."

Types. LECTOTYPE (designated here): US 2808880 (mounted material). **ISOLECTOTYPES:** NCU 18214; US 2808880 (unmounted material in packet). Label data: "PLANTS OF THE SOUTHERN UNITED STATES. EASTERN NORTH CAROLINA. *Panicum filiramum* W.W. Ashe / Near Wilmington N.C. / June 1899 / W.W. Ashe, Collector."

Typification commentary. The type seen by Hitchcock & Chase "in Ashe's herbarium" has never been relocated. A Chase notation on US 2808880 identifies it as "a good match for type loaned Dec 1905." US 2808880 contains an isolectotype in addition to the mounted lectotype. The isolectotype is in a packet "from unmounted dupl. type in Ashe herb." A Chase notation on the lower left of NCU 18214 states "not type of Panicum filirameum / the type is a mounted duplicate of this in Ashe herb loaned Nat Herb Dec 1905." In other words, NCU 18241is a "duplicate" of the now-missing type. In addition to material of *P. filiramum*, NCU 18241 also contains material currently treated as *Dichanthelium dichotomum* (L.) Gould var. *dichotomum*.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum aciculare* Desv.

Current treatment. *Panicum aciculare* is the basionym of *Dichanthelium aciculare* (Desv. ex Poir.) Gould & C.A. Clark (Freckmann & Lelong 2003; LeBlond 2015). My research has determined that plants referable to *P. filiramum* are the same as those identified as *P. chrysopsidifolium* Nash. These plants are currently in preparation for recognition at the rank of species. *Panicum filiramum*, published in 1900, has priority over *P. chyrsopsidifolium*, published in 1903.

5. PANICUM GEORGIANUM Ashe, J. Elisha Mitchell Sci. Soc. 15: 36. 1898. This name, thought to be blocked by *Panicum georgicum* Spreng. 1825, was superfluously replaced by *Panicum cahoonianum* Ashe, J. Elisha Mitchell Sci. Soc. 15: 113. 1899.

Protologue typification. "Dry sandy soil, southern Georgia and Florida. ... Georgia: Small; Darden Junction, McIntosh Co., June 27, 1895. Florida: Chapman; Apalachicola" (Ashe 1898, p. 36).

Type specimen determination by Hitchcock & Chase (1910, p. 169). "The type specimen, which is in the Biltmore Herbarium and which is marked '*P. georgianum* W.W. Ashe,' in Ashe's writing, is the autumnal form."

Types. LECTOTYPE (designated here): US 742690. **ISOLECTOTYPES:** NCU 17707; NY 381606, 413982; US 2808870. Label data: "GEORGIA PLANTS. COLLECTED ABOUT DARIEN JUNCTION, MCINTOSH CO. BY JOHN K. SMALL, JUNE 25-27, 1895. *Panicum Georgianum* Ashe. At sea level."

Typification commentary. Ashe misnamed the site as "Darden Junction" in the protologue. The Biltmore Herbarium specimen has not been relocated. Hansen & Wunderlin (1988) interpreted the Hitchcock & Chase designation as lectotypification, stating under synonymy of *Dichanthelium ovale*: "*Panicum georgianum* Ashe ... (lectotype, US). Lectotypified by Hitchcock & Chase (Contr. U.S. Natl. Herb. 15: 169. 1910)." There are two sheets from the type collection at US, but Hansen & Wunderlin did not indicate which one they believed to be the lectotype. Neither US sheet has a "*P. georgianum*" notation in Ashe's handwriting, so neither can be the missing Biltmore type.

US 742690 matches the protologue and is identified as the "Type" but not in Ashe's or Chase's handwriting (Chase was the most frequent typification annotator of Ashe *Panicum* specimens in that era). The sheet is identified as having been purchased from Scribner's herbarium by Hitchcock in 1905. This sheet was examined by Hitchcock & Chase (see following discussion of US 2808870) and the specimen placed in synonymy with *Panicum consanguineum* Kunth (which is where they placed the name *P. georgianum*). It is selected here as the lectotype.

US 2808870 contains two plants representing two collections. The plant on the left is the autumnal form and is designated on the sheet as "type of *P. Georgianum*." The plant on the right is the vernal form. There are separate labels for each plant, but as Chase notes, "they are doubtless transposed; the May 20 label [beneath autumnal plant] should go with the vernal culm, and June 25-27 with branching plant which is certainly of same collection as the Darien Junction June 25-27 specimen in Hitchcock herbarium [US 742690, the lectotype here designated]." A notation in E.D. Merrill's handwriting identifies the autumnal plant as "the co-type of *Panicum georgianum*." The May 20 vernal plant, collected from Ocmulgee Swamp, has no standing as a type.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum consanguineum* Kunth.

Current treatment. *Panicum consanguineum* is the basionym of *Dichanthelium consanguineum* (Kunth) Gould & C.A. Clark (Freckmann & Lelong 2003; LeBlond 2015).

6. PANICUM MICROPHYLLUM Ashe, J. Elisha Mitchell Sci. Soc. 15: 61. 1898.

Protologue typification. "Collected by the writer June, 1898, at Chapel Hill, N.C., in moist sunny woods" (Ashe 1898, p. 61).

Type specimen determination by Hitchcock & Chase (1910, p. 210-211). "The type could not be found in Ashe's herbarium, nor any specimens so named by him. The description seems to apply to the autumnal form of *P. meridionale*, though the culms and sheaths described as 'glabrous or pubescent,' seem to indicate that some material of *P. tenue* or other species of the *Ensifolia* was mixed with it."

Types. LECTOTYPE (designated here): NY 381644. **ISOLECTOTYPE:** US 2383610 (fragm. ex NY 381644). Label data: "PLANTS OF THE SOUTHERN UNITED STATES. IN THE VICINITY OF CHAPEL HILL, NORTH CAROLINA. *Panicum microphyllum* Ashe =*P. filiculme* Ashe / June / W.W. Ashe, Collector." "*Panicum microphyllum*" and "June" are in Ashe's handwriting, but "=*Panicum filiculme* Ashe" is in someone else's hand.

Typification commentary. NY 381644 contains a note, "Co-type," in Chase's handwriting, with an arrow pointing to the name *Panicum microphyllum* Ashe on the label. Doubtless this specimen was not seen by Hitchcock & Chase until after the 1910 publication, where they stated they had not seen "any specimens so named by him." The Gould annotation label from 1978 denotes this specimen as an isolectotype, apparently interpreting Hitchcock & Chase as designating the missing Ashe herbarium specimen as the lectotype. But their usual method of designating what is now regarded as a lectotype was with the phrase "chosen [or taken] as the type," and circumstances indicate they did not designate specimens they hadn't seen.

US 2383610 contains a small fragment of the "Co-type," very likely the specimen at NY, which is the only known specimen matching the protologue.

At NCU is a specimen (17715) with a printed label identifying it as "*Panicum microphyllum* / Moist, grassy lands, Chapel Hill, Orange County, N.C. / Date May 26, 1898 / Coll. W.W. Ashe." There is just enough variance in the date ("May" instead of "June") and habitat ("Moist, grassy lands" instead of "sunny woods") to disqualify it as a type. Nonetheless, it may well have been regarded by Ashe as a syntype or paratype equivalent, with omission of its differing date and habitat from the protologue a common oversight of the time.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum meridionale* Ashe.

Current treatment. *Panicum meridionale* is the basionym of *Dichanthelium meridionale* (Ashe) Freckmann (LeBlond 2015), and a synonym of *D. acuminatum* (Sw.) Gould & C.A. Clark subsp. *implicatum* (Scribn. ex Nash) Freckmann & Lelong (Freckmann & Lelong 2003).

7. PANICUM NEMOPANTHUM Ashe, J. Elisha Mitchell Sci. Soc. 15: 42. 1898.

Protologue typification. "Type material collected by the writer April, 1895, in the Penitentiary woods, Raleigh, N.C." (Ashe 1898, p. 42).

Type specimen determination by Hitchcock & Chase (1910, p. 177). "The type could not be found in Ashe's herbarium, but a specimen from the type material labeled in Ashe's handwriting is

in the National Herbarium. This is a single vernal culm with an immature, partly included panicle; the spikelets are nearly or quite glabrous."

Types. LECTOTYPE (designated here): US 2383604. **TOPOLECTOTYPE:** NCU 17850. Label data: "PLANTS OF THE SOUTHERN UNITED STATES / *Panicum nemopanthum* Ashe / Raleigh N.C. / April 1895 / W.W. Ashe, Collector."

Typification commentary. Chase designated the US specimen as a "Co-type," and it was subsequently treated as an isotype of the missing type in Ashe's herbarium. Since the Ashe type has not been relocated, the US "Co-type" is selected as the lectotype. The topolectotype was collected by Ashe from Penitentiary woods on May 1, 1899.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum bicknellii* Nash.

Current treatment. *Panicum bicknellii* was treated as a synonym of *Dichanthelium boreale* (Nash) Freckmann by Gould & Clark (1978). It is regarded as a "putative hybrid" by Freckmann & Lelong (2003), who did not treat it in synonymy. My research has determined that *P. bicknellii* should be recognized at the rank of species (as *Dichanthelium bicknellii*), and a new treatment is in preparation.

8. PANICUM ONSLOWENSE Ashe, J. Elisha Mitchell Sci. Soc. 16: 88. 1900.

Protologue typification. "In the eastern part of Onslow county, N.C., where the type material was collected near Ward's Mill" (Ashe 1900, p. 88).

Type specimen determination by Hitchcock & Chase (1910, p. 276). "The type, in Ashe's herbarium, is the vernal form with immature panicles, the culms glabrous or minutely puberulent, the lower blades as much as 1 cm. wide, and immature spikelets 2.4 mm. long. Other specimens in Ashe's herbarium and some distributed as *P. onslowense* and bearing the same data as the type are *P. lanceariun*."

Types. LECTOTYPE (designated here): US 2808968. **SYNTYPE:** NCU 18104. Label data: "PLANTS OF THE SOUTHERN UNITED STATES. EASTERN NORTH CAROLINA. May, 19-20, 1899. 11. m. East of Jacksonville, Onslow Co. / W.W. Ashe, Collector."

Typification commentary. Confusion exists between the typification described by Hitchcock and Chase and the notations on the two extant type specimens. Hansen and Wunderlin (1988) interpreted the Hitchcock & Chase type designation as lectotypification of a specimen at NCU. They also indicated there was at least one other type specimen ("isotype") present at NCU, but no other NCU type specimen is known. They noted that Hitchcock and Chase "clearly stated that the type is in Ashe's herbarium, now at NCU."

The Chase notation on syntype NCU 18104 reads "type of *P. onslowense* a mounted specimen in Ashe herb. loaned Nat Herb Dec 1905." I interpret this to mean that the type designated by Hitchcock & Chase was not NCU 18104 but instead another mounted specimen loaned by Ashe to the National Herbarium in 1905. If Chase had interpreted NCU 18104 as the type, she would not have used the phrase "a mounted specimen" etc. US 2808968, the only other known type sheet, has a U.S. Department of Agriculture label prepared by E.D. Merrill, not by Ashe, and noted by Merrill as "Portion of type sent by Ashe June 1900 [1899 crossed out]." This suggests that the mounted material on US 2808968 was either from unmounted material sent by Ashe or from another mounted specimen sent in 1900, not 1905.

Further complicating matters is that two taxa are present in the type material: *P. webberianum* Nash and *P. lancearium* Trinius. Hitchcock and Chase recognized this in their discussion of typification. NCU 18104 is conspecific with *P. lancearium*, while US 2808968 is conspecific with *P. webberianum*. The protologue matches *P. webberianum*, which is where Hitchcock and Chase placed *P. onslowense*.

Hitchcock and Chase described the type "in Ashe's herbarium" as "the vernal form with immature panicles." This condition matches that of NCU 18104, but the remainder of their description belongs to *P. webberianum*, not *P. lancearium*. The vernal panicles on US 2808968 are mature. This is added evidence that neither US 2808968 nor NCU 18104 represents the "mounted specimen in Ashe herb. loaned Nat Herb Dec 1905." The specimen at NCU does not match the protologue while the specimen at US does, and the latter is selected as the lectotype. Since NCU 18104 is conspecific with *P. lancearium*, it is a syntype.

Taxonomic treatment by Hitchcock & Chase (1910). Synonym of *Panicum webberianum* Nash.

Current treatment. *Panicum webberianum* is the basionym of *Dichanthelium webberianum* (Nash) LeBlond (LeBlond 2015) and a synonym of *D. portoricense* (Desv. ex Poir.) B.F. Hansen & Wunderlin subsp. *patulum* (Scribn. & Merr.) Freckmann & Lelong (Freckman & Lelong 2003).

9. PANICUM SUBVILLOSUM Ashe, J. Elisha Mitchell Sci. Soc. 16: 86-87. 1900.

Protologue typification. "Collected by the writer at Carlton, Minnesota, in August, in the simple state. Type material preserved in my herbarium" (Ashe 1900, p. 87).

Type specimen determination by Hitchcock & Chase (1910, p. 227). "The type specimen, in Ashe's herbarium, consists of three tufts of several culms each, 15 to 30 cm. high, with leaves clustered at the base and long-exserted mature panicles."

Types. LECTOTYPE (designated here): US 2382624 (fragm. & photo). **ISOLECTOTYPES:** NCU 18025; US 971092. Label data (from photo of missing holotype): "PLANTS OF THE SOUTHERN UNITED STATES ["SOUTHERN" crossed out]. ["EASTERN NORTH CAROLINA" crossed out] / *Panicum subvillosum* W.W. Ashe / Carlton Minn. / Aug 1899 / W.W. Ashe, Collector."

Typification commentary. The type from Ashe's herbarium has not been located. The specimen at NCU, which has been treated as the holotype (e.g., Hansen & Wunderlin 1988), has the following Chase note: "dupl. type / *P. subvillosum* Ashe / type is a mounted specimen in Ashe herb. loaned Nat Herb Dec 1905." There is a photograph of the missing Ashe herbarium type on US 2382624 along with a small tuft of mounted material presumably from the Ashe herbarium type and material in a packet noted as "from holotype." For these reasons US 2382624 has been selected as the lectotype. Neither NCU 18025 nor US 971092 matches the image of the missing Ashe herbarium type. US 971092 was also identified as a duplicate type by Chase, with the note "from unmounted material in Ashe herb." No other type specimens are known.

Taxonomic treatment by Hitchcock & Chase (1910). *Panicum subvillosum*.

Current treatment. *Panicum subvillosum* is a synonym of *Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark subsp. *fasciculatum* (Torr.) Freckmann & Lelong (Freckmann & Lelong 2003). Specimens referred to *Panicum subvillosum* are not treated by LeBlond as they are outside the range of the Weakley Flora (LeBlond 2015).

ACKNOWLEDGEMENTS

I am indebted to John Boggan and Robert Soreng of the Department of Botany at the National Herbarium for a careful reading of the manuscript and assistance with typification wrangling. Carol Ann McCormick, assistant curator of the University of North Carolina Herbarium at Chapel Hill (NCU), provided oversight and management of the NCU collection and loans from other herbaria.

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VALIDATING THE NAME OF A MEXICAN *AGERATINA* (ASTERACEAE)

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ABSTRACT

Kyrstenia calophylla Greene, closely allied to *Ageratina calaminthifolia*, has been previously transferred to *Eupatorium* but was invalidly combined under *Ageratina*. The name is validated here as **Ageratina calophylla** (Greene) R.M. King & H. Rob. ex Molinari & Mayta, **comb. nov.**

While making a bibliographic review of the Eupatorieae, the first author found an invalid combination for *Ageratina* that, despite its acceptance, has never been corrected. The error also has been pointed out in Tropicos (2015).

Greene (1903) described *Kyrstenia calophylla* on the basis of a collection by Edward Palmer in northern Mexico. He stated that the new species had been misidentified by the collector and distributed as *Eupatorium calaminthifolium* Kunth. Robinson (1925) transferred *K. calophylla* to *Eupatorium* and again emphasized the distinctiveness of the species when compared to *E. calaminthifolium*.

King and Robinson (1970) transferred *Kyrstenia calophylla* to *Ageratina*, but this combination was invalid according to Article 41.8a of the ICN (McNeill et al. 2012), since they cited "*Eupatorium calophyllum* B.L. Robinson" as the basionym instead of Greene's original species. The name in *Ageratina* is validated here.

Ageratina calophylla (Greene) R.M. King & H. Rob. ex Molinari & Mayta, **comb. nov.** *Kyrstenia calophylla* Greene, Leafl. Bot. Observ. Crit. 1: 11. 1903. *Eupatorium calophylhum* (Greene) B.L. Rob., Contr. Gray Herb. 75: 5. 1925. **TYPE: MEXICO. Coahuila.** Saltillo, 1898, *E. Palmer 318* (holotype: US digital image!; isotype: MO digital image!).

This species, as "*Ageratina calophylla* King & Rob.," has been included in phytochemical research (Fang et al. 1986), taxonomic treatments (Turner 1997), and floristic checklists (Villaseñor & Ortiz 2012).

ACKNOWLEDGEMENTS

Thanks to Guy Nesom and Barbara Hellenthal for review and comments.

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JASMINUM LAURIFOLIUM (OLEACEAE) ADVENTIVE IN TEXAS, WITH OBSERVATIONS ON ALIEN PLANT INVASIONS AND DISTRIBUTION ON THE TEXAS GULF COAST BY PASSERINES

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ABSTRACT

Jasminum laurifolium is reported as naturalized in Nueces County of the central Texas Gulf coast. A brief history of the genus in Texas and Florida is presented as well as information on the occurrence of *J. laurifolium*. Indications are that *Schinus terebinthifolius*, a major invasive plant on the Texas coast, may have facilitated this introduction by attracting migrating frugivorous birds and creating open niches that can be exploited by certain subtropical and tropical plants, including species yet to become established.

The genus *Jasminum* (Oleaceae) consists of 200+ species of trees and erect or scandent shrubs. These are native to Africa, Asia, Australia, South Pacific Islands, and one species in the Mediterranean region (Chang Mei-chen et al. 1996). They are widely used as ornamentals in the tropical and subtropical areas of the world. At least ten species of *Jasminum* have been imported into the USA (Read 1962) and a number of species have been used to a considerable extent in landscaping pursuits. However, the name "jasmine" has been liberally applied to numerous horticultural plants, commonly misidentified or listed in synonymy, such that correct names for numerous horticultural species versus trade names is confusing (Dickey 1949). The consequences of continued use of incorrect names provide a long history of misunderstanding regarding what species were originally cultivated. The most widely naturalized species both are yellow-flowered and known as yellow jasmine: *J. mesnyi* Hance of Alabama, Arizona, Florida Georgia, Louisiana, and Texas and *J. nudiflorum* Lindl. of Alabama, Georgia, Missouri, Oklahoma, Tennessee, and Texas (Kartesz 2015). The remaining species are white-flowered, regardless of seasonal phenology, and occur in Florida.

Correll and Johnston (1970) mentioned that *Jasminum* is commonly cultivated in Texas and occasionally volunteers or escapes, but they cited no species names. Jones et al. (1997) included 6 species in their checklist of the Texas flora, but all were noted to be cultivated. Turner et al. (2003) did not map any species of the genus in their atlas, nor were any listed as adventive. *Jasminum mesnyi* (Hardin 1974) and *J. nudiflorum* (Diggs et al. 1999) are reported to be

adventive in Texas. *Jasminum laurifolium* (angel-wing jasmine, star jasmine, windmill jasmine, confederate jasmine), a native of Bangladesh and India (Green 1984), and introduced to the West Indies, Admiralty Islands, Papua New Guinea and China (Read 1962; Bailey & Bailey 1976; Green 1984; Wunderlin 1998; Chang Mei-chen et al. 1996; Nesom 2015 pers. comm.) is here reported as adventive to the central Texas coastal plain.

Jasminum laurifolium Roxburgh ex Hornemann (syn = *J. nitidum* Skan). Voucher: **TEXAS**. Nueces Co.: 1.3 mi E on Hwy 361 from jct of Hwy 90 (Commerce Street) and Hwy 361 in Aransas Pass; to Stedman Island, take first left onto dirt road (N side of Hwy 361), then right (east) paralleling bay for 10 m, 25 Feb 2015, *Singhurst 21,337* (BAYLU). Figure 1. Three multi-branch shrubs with vining-like stems were growing among and under *Schinus terebinthifolius* in the sandy coastal prairie and saline flats transition. Associated species include *Borrichia frutescens*, *Coreopsis nuecensoides*, *Gaillardia pulchella*, *Iva frutescens*, *Rayjacksonia phyllocephala*, *Thelesperma nuecense*, *Opuntia* sp., *Sophora tomentosa*, *Sisyrinchium* sp., *Linum* sp., *Distichlis spicata*, *Spartina spartinae*, *Schizachyrium littorale*, *Anagallis arvensis*, *Stenaria nigricans*, *Verbena xutha*, and *Verbena* sp.

Figure 1. *Jasminum laurifolium*, with white flower and large, long-acuminate, glossy, evergreen leaves. The foliage, rusty-red fruits, and branches of *Schinus terebinthifolius* serve as perching sites for passerines. Photo by Jason Singhurst, 25 February 2015, Nueces County.

This marks the second state of the USA in which *Jasminum laurifolium* has been documented. It is also known from Dade County, Florida, where it is mapped as adventive to Florida (Wunderlin 1998; Wunderlin and Hansen 2008; Kartesz 2015).

Jasminum laurifolium has escaped cultivation and been naturalized in Florida since the 1990s (Wunderlin 1998), vouchered from Dade Co. (*Craighead s.n.,* USF 64191). An accession of *J. laurifolium* plants, under the synonym *J. nitidum* Skan, received from Lemoine & Son of the city of Nancy, France, was recorded at the Plant Introduction Station in Miami during 1930 under P.I. 90315 (Read 1962). At least five species of *Jasminum* have documented importations into the United States via this facility (Read 1962). Known today as the Subtropical Horticulture Research Station (SHRS), this facility was originally envisioned for the importation, field trial, and distribution of plants (Popenoe 1922). Numerous plant species and their seeds were brought in for horticultural production in this country, in efforts to diversify gardens and reduce disease spread by imported plants (Fairchild 1934). Ironically, these criteria failed to specifically measure ecological penalties on native floral regimes.

Figure 2. *Jasminum laurifolium*, 25 February 2015, Nueces Co., Texas. Photo by Jason Singhurst.

Dispersal and establishment of adventives in Texas by passerines

Recent coastal discoveries in Texas, e.g., *Senna bicapsularis* (Singhurst et al., 2013) and *Jasminum laurifolium* (this report), have been found in proximity to *Schinus terebinthifolius*. Whether the association with *J. laurifolium* is related to disturbance, influence of a perturbation of *S. terebinthifolius* on ecological succession, or *S. terebinthifolius* merely acting as a nursery tree for other nonnatives is unknown. This association may simply occur as a feature of locally ubiquitous coastal presence of *S. terebinthifolius* in Texas or these coastal sites may provide unoccupied niche sites exploited by certain subtropical and tropical shrub species. This niche exploitation seems promoted by the arborescent nature of *S. terebinthifolius*, which appears to be attractive to perching birds (passerines), a primary dispersal agent of seeds (Ewel et al. 1982; Curnutt 1989). These bird species may be winter coastal residents or Neotropical migrants, yet both assemblages participate in some level of seasonal frugivory e.g., *Turdus migratorius*

(American Robin), *Bombycilla cedrorum* (Cedar Waxwing), *Dumetella carolinensis* (Gray Catbird), *Pipilo erythrophthalmus* (Eastern Towhee), *Vireo olivaceus* (Red-eyed Vireo), *Myiarchus crinitus* (Great-crested Flycatcher), and various other Turdids, Vireonids, Tyrannids and Cardinalids.

Additional recent exotic species discovered in the Texas coastal area, e.g., *Carissa macrocarpa* (Singhurst & Holmes 2010) and *Coccoloba uvifolia* (Singhurst & Holmes 2014), have life history attributes similar to *Schinus terebinthifolius*: trees serving as perching sites and fruit dispersal by various passerines (Ewel et al. 1982; Parrotta 1994; Mishra & Gupta 2005) and tolerance of saline coastal soils. The periodic irruptions by migratory frugivorous passerines, in combination with plant proximity to migratory landfalls and timing of fruit development, has the potential to expand colonization of these naturalized plant species. Other arborescent species, except palms, are not as abundant nor do they attain the density and size of *S. terebinthifolius*. Palms along the south Texas coast are mainly planted, generally in human residential areas, and lack a favorable fruit and growth form to attract passerines. Niche occupation by exotic fruiting plant species and rapid formation of novel mutualism with migrating passerines suggest that coastal Texas may be experiencing a dispersal lag-phase of these exotics and other nonnative fruit-bearers yet to come.

ACKNOWLEDGEMENT

The authors thank Guy Nesom for his assistance and identification of the species reported.

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Published 18 June 2015. ISSN 2153 733X

ERIGERON HODGSONIAE (ASTERACEAE), A NEW SPECIES FROM CENTRAL ARIZONA

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ABSTRACT

Erigeron hodgsoniae Nesom, **sp. nov.**, is described from the Sierra Ancha of Gila Co., Arizona, where it is known only by four collections from an extended population in Cold Water Canyon and close vicinity along Cherry Creek. It is the fifth member of the *E. pringlei* group (with *E. anchana*, *E. heliographis*, *E. pringlei*, and *E. saxatilis*) and is from a locality within the geographic range of *E. anchana*. All five species are perennials in rocky habitats and endemic to Arizona. *Erigeron hodgsoniae* is only one with prominently hairy stems and leaves — each of the others is glabrous or nearly so.

The *Erigeron pringlei* group has included four species that are restricted to rocky habitats in Arizona (Nesom 1990; Nesom 2008, as Group B of *Erigeron* sect. *Scopulincola*). Collections since 1990 have shown the previously recognized species to be consistent in morphology. One set of collections, however, from within the geographic range of *E. anchana* is so distinct that it is here formally described as a fifth species of the group. It apparently a narrow endemic, known here only from an extended population in Cold Water Canyon and close vicinity along Cherry Creek, in the Sierra Ancha (Fig. 1).

Erigeron hodgsoniae Nesom, **sp. nov.** **TYPE: USA. Arizona**. Gila Co.: Sierra Ancha Mts, along Cherry Creek ca. 75 yards N of waterfalls on S side of creek, just below (S of) Cold Water Canyon, T6N R14E Sect 3 center of NE 1/4, 110° 53" 56' W, 33° 53" 28' N, partially shaded, steep part of NE-facing quartzite (?) cliff above bouldery creek, 3800 ft, with *Quercus turbinella*, *Quercus emoryi*, *Juniper*, *Arctostaphylos*, *Agave chrysantha*, *Cercocarpus*, *Pinus edulis*, and *Sphaeralcea*, locally frequent, rays white, 2 May 1993, *W. Hodgson 7124* with L. Ecker (holotype: DES digital image!, Fig. 2; isotype: ASU!).

Similar to species of the *Erigeron pringlei* group in its geographic range, rocky habitat, perennial duration, caudex branches with persistent old petiole bases, small heads, and ray florets reflexing at the tube/lamina junction; similar to *E. anchana* in its entire, elliptic-oblanceolate leaves continuing essentially unreduced in size along the stems. Different from the other four species in its villous stems and leaves.

Perennial herbs, taprooted, producing thick caudex branches 1–5 cm long and roughened with persistent, old petiole bases. **Stems** 7–25 cm long, decumbent-ascending to sprawling-pendent, distally ascending, unbranched, moderately villous with irregularly spreading but generally retrorsely oriented, multicellular, acicular hairs 0.4–0.8 mm long, eglandular. **Leaves** villous to hirsute-villous, eglandular, basal 3–5.5 cm long, blades elliptic to obovate or oblanceolate-obovate, 15–20 mm long, 4–11 mm wide, attenuate to a petiole 20–35 mm long and ca. 2–3 times longer than the blade, apices acute-apiculate, margins entire, cauline quickly becoming epetiolate distally but blades slightly or not at all reduced in size upward. **Heads** solitary, 8–10 mm wide (pressed) on minutely bracteate peduncles 3–4 cm long; phyllaries elliptic-oblanceolate, sparsely hirsute in the midregion, without a prominent oil duct, eglandular, in 2–3 series weakly graduate or even in length, innermost 3.5–4 mm long, margins shallowly lacerate. **Ray flowers** 40–50 in a single series, corollas 8–9 mm long, reflexing at maturity at the tube-lamina junction, lamina white, drying pink to light purplish, without a midstripe, 0.6–1 mm wide. **Disc corollas** narrowly tubular-funnelform, 2–2.4 mm long. **Achenes** ca.

1.4 mm long, sparsely strigose; pappus of 10–14 persistent bristles ca. 2.5 mm long, with a few minute squamellae 0.2–0.3 mm long. **Flowering** (Apr–)May–Jun.

Additional collections examined, all from Cold Water Canyon and just outside its mouth on the same day as the type collection, in the same habitat (cliff faces and steep walls) and apparently representing a single, extended population. **Arizona**. Gila Co: Sierra Ancha Mountains in Cold Water Canyon, ca. halfway between Cherry Creek Rapd (FSR 203) and Cherry Creek, 4000 ft, *Hodgson 7120* (DES digital image!, Fig. 4); Sierra Ancha Mountains in Cold Water Canyon, ca. 200 yds. above Cherry Creek, 3900 ft, *Hodgson 7122* (DES digital image!, Fig. 3); Sierra Ancha Mountains along Cherry Creek at and above (S side of creek) waterfalls, just below (S of) Cold Water Canyon, 3800 ft, *Hodgson 7123* (DES digital image!).

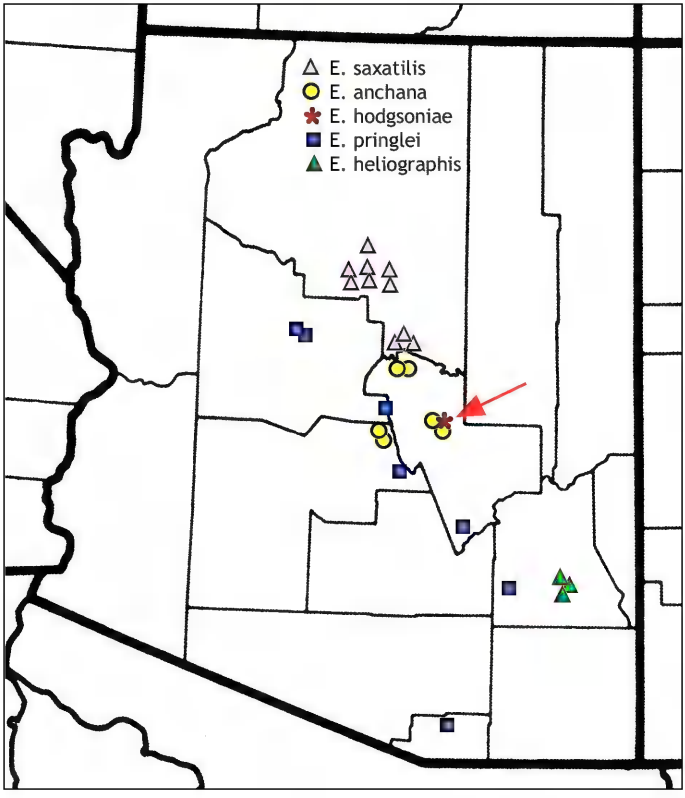

Figure 1. Distribution of the *Erigeron pringlei* group. Arrow points to locality of *E. hodgsoniae*. Map based on previous records and new ones from recent study at the ASU herbarium.

HOLOTYPE
Erigeron hodgsoniae Nesom
G. Nesom 2015
ASTERACEAE OF ARIZONA
Erigeron anchana Nesom
GILA COUNTY. Sierra Ancha Mountains, along Cherry Creek ca 75 yards north of waterfalls on south side of Creek, just below (south of) Cold Water Canyon, T6N R14E Section 3 center of NE1/4, 110DEG 51'56" W long, 33DEG 53'28" N lat, 3800 ft, 1158 meters.
Partially shaded steep part of NE-facing quartzite(?) cliff above bouldery creek, with Arctostaphylos, Quercus turbinella, Q. emoryi, Sphaeralcea, Juniperus, Agave chrysantha, Cercocarpus, Pinus edulis. Locally frequent herbaceous perennial, rays white.
2 May 1993
Liz Ecker
Wendy Hodgson 7124
Herbarium of Desert Botanical Garden (DES)
HERBARIUM
DES
DATABASE
DES0000785B

Figure 2. Holotype of *Erigeron hodgsoniae*, DES.

DESERT BOTANICAL GARDEN
ASTERACEAE OF ARIZONA
Erigeron anchana Nesom
GILA COUNTY. Sierra Ancha Mountains, in Cold Water Canyon, approximately 200 yards above Cherry Creek, T6N R14E Section 3 extreme NW1/4NE1/4, 110DEG 54'00" W long, 33DEG 53'38" N lat, 3900 ft, 1188 meters.
Partially shaded steep part of canyon/creek, S-facing quartzite(?) cliff above bouldery creek, with Arctostaphylos, Quercus turbinella, Q. emoryi, Sphaeralcea, Juniperus, Agave chrysantha, Cercocarpus, Pinus edulis. Local herbaceous perennial, rays white.
2 May 1992
Liz Ecker
Wendy Hodgson 7122
Herbarium of Desert Botanical Garden (DES)
HERBARIUM
DES
DATABASE
DES0003787

Figure 3. *Erigeron hodgsoniae*, *Hodgson 7122*, DES.

DESERT BOTANICAL GARDEN
ASTERACEAE OF ARIZONA
Erigeron anchana Nesom
GILA COUNTY. Sierra Ancha Mountains, in Cold Water Canyon, approximately halfway between Cherry Creek Road (FSR 203) and Cherry Creek, T6N R14E Section 3 extreme NW1/4NE1/4. 110DEG 54'08" W long, 33DEG 53'38" N lat, 1000 ft, 1219 meters.
Partially shaded steep part of canyon/creek, N-facing quartzite(?) cliff above boulder creek, with Arctostaphylos, Quercus turbinella, Q. emoryi, Sphaeralcea, Juniperus, Agave chrysantha, Cercocarpus, Pseudotsuga, Pinus edulis. Locally common herbaceous perennial, rays white.
2 May 1993
Liz Ecker
Wendy Hodgson 7120
Herbarium of Desert Botanical Garden (DES)
HERBARIUM
DES
DATABASE

Figure 4. *Erigeron hodgsoniae*, *Hodgson 7120*, DES.

The new species is named for its collector, Wendy Hodgson, Curator of the Herbarium and Senior Research Botanist at the Desert Botanical Garden in Phoenix. She is a long-time student of floristics and ethnobotany of Arizona and the Sonoran Desert, an illustrator and author, and currently a specialist in the taxonomy of Cactaceae and Agavaceae.

Among the *Erigeron pringlei* group, it is a reasonable hypothesis that *E. hodgsoniae* is most closely related to *E. anchana* and *E. saxatilis*, which are similar to it in leaf morphology — but an accurate understanding of evolutionary relationships probably will require molecular evidence. *Erigeron anchana* and *E. hodgsoniae* have cauline leaves relatively even-sized along the stems. Basal leaves of *E. anchana* usually are entire but populational variability sometimes includes plants with 3(–5)-lobed or -toothed basal leaves, perhaps reflecting a residual ancestral tendency (suggesting *E. pringlei* as closely related) or else historical introgression from *E. pringlei*. A good example of this is *Lehr & Weber 990* (DES, digital image!) from the Tonto Creek area in northern Gila County, close to but apparently outside an area of potential sympatry with *E. pringlei*. All leaves of *E. hodgsoniae* are entire-margined.

Erigeron hodgsoniae is sympatric in the Sierra Ancha with *E. anchana*, which is now known from there by numerous collections. Besides the immediately evident difference in vestiture, the two are distinct in other features.

1. Stems villous, leaves villous to hirsute-villous on both surfaces, hairs 0.4–0.8 mm long; leaf apices acute-apiculate; heads 8–10 mm wide (pressed); phyllaries barely or not at all graduate in length, sparsely hirsute, midregion without a prominent oil duct; ray florets 40–50; pappus bristles 10–14 ..... **Erigeron hodgsoniae**

1. Stems glabrous to sparsely strigose, leaves glabrous or sparsely and minutely strigose adaxially (glabrous abaxially), hairs 0.1–0.2 mm long; leaf apices acute with a sharp mucro but not apiculate; heads 5–7 mm wide (pressed); phyllaries strongly graduate in length, glabrous, midregion with a conspicuous oil duct; ray florets 24–36; pappus bristles 19–26 ..... **Erigeron anchana**

ACKNOWLEDGEMENTS

I'm grateful to the ASU staff for help during recent study there. Photos and information on DES collections were provided by Wendy Hodgson and Andrew Salywon.

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VARIATION IN *ERYTHRANTHE CORDATA* (PHRYMACEAE) IN ARIZONA

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ABSTRACT

Plants of *Erythranthe cordata* vary greatly in size but are consistently distinguished from *E. guttata* sensu stricto in their small corollas, autogamous breeding, and lack of rhizomes. Aspects of size variability and vegetative and floral morphology in *E. cordata* are shown in photos of collections from the state of Arizona.

Erythranthe cordata (Greene) Nesom of the southwestern USA and adjacent Mexico (Fig. 1) has often been misidentified as *E. guttata* (Fischer ex DC.) Nesom within an inclusive, polymorphic concept of the latter, but *E. cordata* is distinct in its lack of rhizomes and its autogamous flowers. A difference in chromosome number (x = 15 in *E. cordata* vs. x = 14 in *E. guttata*) points to their evolutionary distinction. Recent study in the ASU herbarium has occasioned this overview of *E. cordata* as it occurs in Arizona, with the aim of clarifying its identity and its distinction from *E. guttata*.

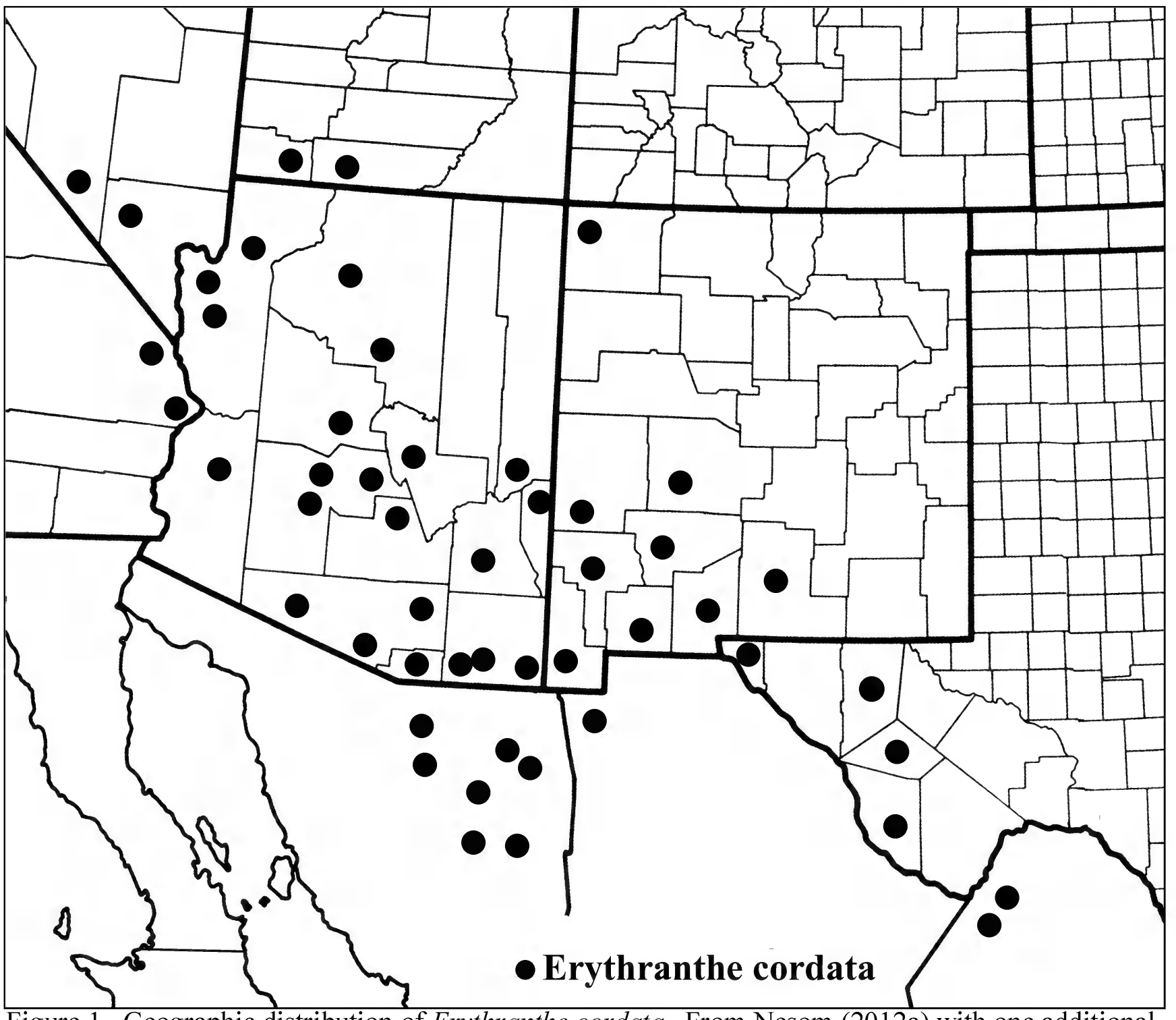


Figure 1. Geographic distribution of *Erythranthe cordata*. From Nesom (2012a) with one additional record for Arizona.

Within *Erythranthe* sect. *Simiola*, *E. cordata* has been regarded as a member of the "*E. arvensis* group" — *E. cordata* plus the *E. arvensis* complex, including *E. brachystylis* and *E. charlestonensis* — each of which is annual (without rhizomes but sometimes with adventitious roots at lower nodes) and produces autogamous flowers (often with small, obviously cleistogamous corollas) mostly produced from distal nodes (Nesom 2012a, 2014a and b). Whether the similar reduced floral features and associated biology in *E. cordata* and *E. arvensis* are strictly homologous or independently evolved probably will be determined by molecular comparisons.

Erythranthe cordata and *E. arvensis* are essentially allopatric, the latter occurring mostly in more northern regions and not documented as a member of the Arizona flora. Typical *E. guttata*, however, occurs widely in Arizona and is distinguished from *E. cordata* by the following contrasts.

1. Rhizomatous; corolla tubes (10–)12–20(–26) mm, exserted 3–5 beyond calyx margin, limb expanded 12–24(–25) mm (pressed); styles 15–20 mm, exserted 6–9 mm beyond fruiting calyx margin; stigma above level of anthers (herkogamous), reproduction allogamous; chromosome numbers $2n = 28, 56$ (x = 14) ..... **Erythranthe guttata**

1. Without rhizomes, fibrous-rooted; corolla tubes 5–14 mm, exserted 1–3 mm beyond calyx margin, limb expanded 9–14 mm (pressed); styles 7–10 mm, exserted 1–3 beyond fruiting calyx margin; stigma at same level as anthers (plesiogamous), reproduction autogamous; chromosome number $2n = 60$ (x = 15) ..... **Erythranthe cordata**

Even if basal parts are not available and corollas have been shed, contrasts in style length provide an effective distinction. In *E. cordata*, the persistent style is short-exserted from the calyx, reflecting the short corolla tube and plesiogamous arrangement of stigma and anthers (Nesom 2012b). In *E. guttata*, the persistent style is longer, reflecting the longer corolla tube and herkogamous arrangement of stigma and anthers.

Figure 1. *Erythranthe cordata*. Relatively large corolla of autogamous flower, short-tubed with throat closed and stigma and anthers within the tube. Cochise Co., Arizona, San Pedro Riparian National Conservation Area, 13 Apr 2002, *Makings 943*, ASU. Photo by Liz Makings. See Figure 2.

Figure 2. *Erythranthe cordata.* Cochise Co., Arizona, San Pedro Riparian National Conservation Area, 13 Apr 2002, *Makings 943*, ASU. Arrows point to small corollas and short styles. Photo mounted on sheet and in Figure 1 is from the same population.

Plants of *Erythranthe cordata* are highly variable in size — from tiny fibrous-rooted plants with nearly filiform stems to much larger individuals with fistulose stems adventitiously rooting at proximal nodes. Label comments for a collection of *E. cordata* from Kane Co., Utah (*Reveal 819*), are representative of this variation: "This population is exceedingly variable as the plants range from less than 1 cm high to over 8 dm high; growing both in seeps where the plants are large to sandy flats along the stream where the plants are 1-4 dm high, to grassy flats where the same plants were as small as 1 cm."

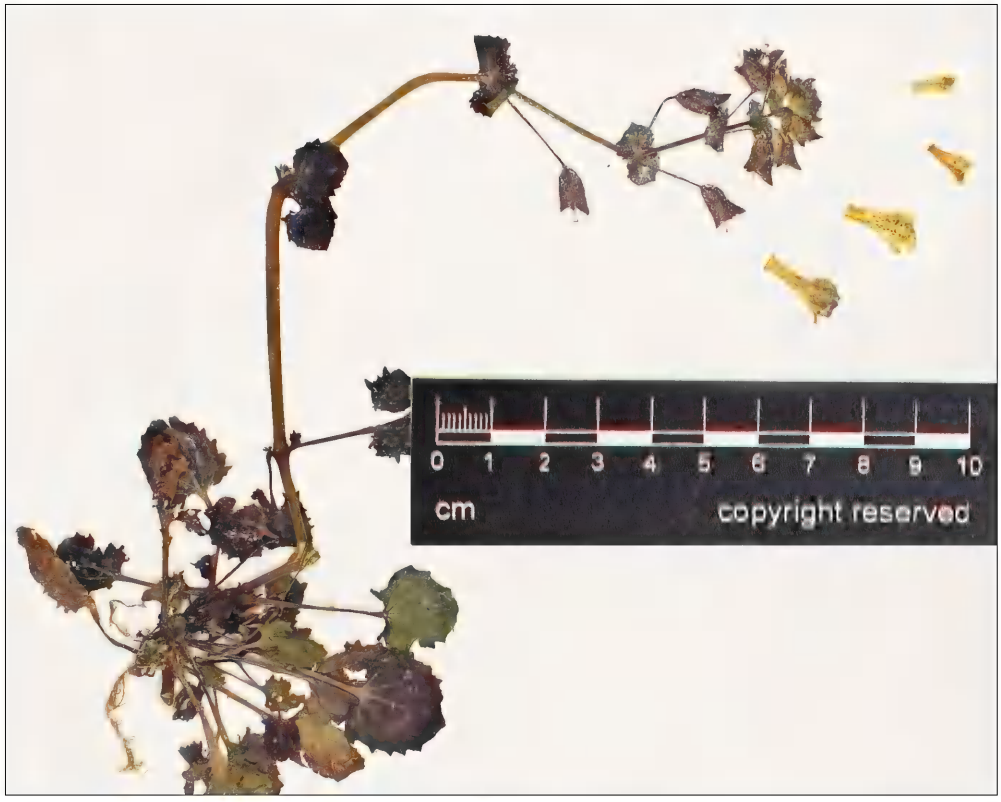
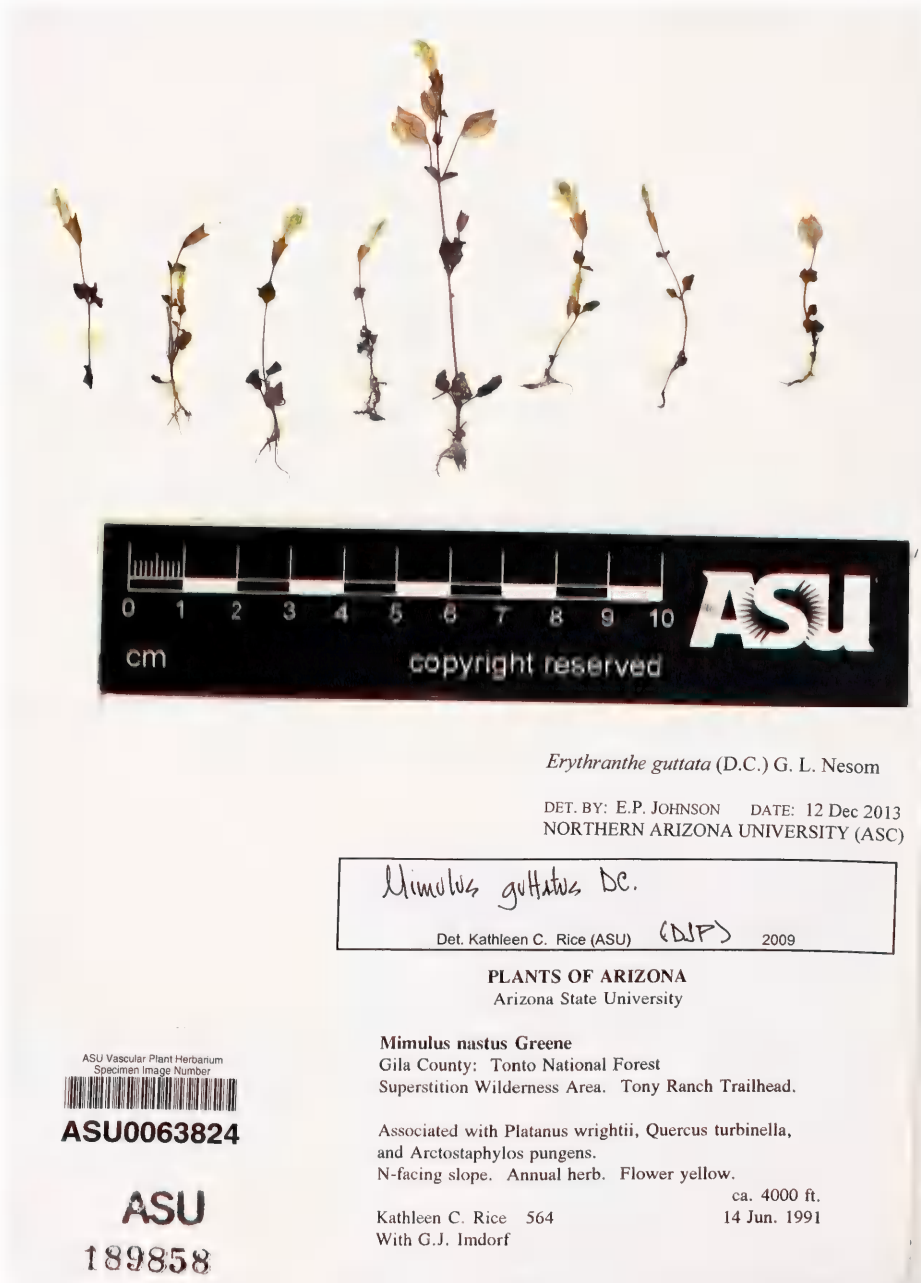


Figure 3. *Erythranthe cordata*. Maricopa Co., Arizona, Lake Pleasant Regional Park, 12 Mar 1967, *Lehto 7750*, ASU. Corollas are 8–15 mm long, the tubes 5–8 mm.

The collections *Erythranthe cordata* shown below are arranged generally by increasing size of plants. Figures 4-6 show strictly fibrous-rooted plants; Figures 7-9 show increasingly larger plants with adventitiously rooting lower stems.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cm
copyright reserved
ASU
Erythranthe guttata (D.C.) G. L. Nesom
DET. BY: E.P. JOHNSON DATE: 12 Dec 2013
NORTHERN ARIZONA UNIVERSITY (ASC)
Mimulus guttatus DC.
Det. Kathleen C. Rice (ASU) (DJF) 2009
PLANTS OF ARIZONA
Arizona State University
ASU Vascular Plant Herbarium
Specimen Image Number
ASU0063824
ASU
189858
Mimulus nastus Greene
Gila County: Tonto National Forest
Superstition Wilderness Area. Tony Ranch Trailhead.
Associated with Platanus wrightii, Quercus turbinella,
and Arctostaphylos pungens.
N-facing slope. Annual herb. Flower yellow.
ca. 4000 ft.
Kathleen C. Rice 564 14 Jun. 1991
With G.J. Imdorf

Figure 4. *Erythranthe cordata.* Gila Co., Arizona, 14 Jun 1991, *Rice 564*, ASU. Smallest plants are ca. 3 cm tall.

Figure 5. *Erythranthe cordata*. Gila Co., Arizona, 3 May 1993, *Christy 1443*, ASU. Plants range from 4 to 20 cm tall.

Arizona State University (ASU)
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Vascular Plant Herbarium
Specimen entered in ASU Database
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0 1 2 3 4 5 6 7 8 9 10
Plants of Arizona
Scrophulariaceae
Mimulus guttatus DC.
USA. Arizona. Gila. Mt. Ord; Slate Creek upper, just off Hwy 87 approx 1 mile S of old Slate Creek Rd (FS 26?). In creekbed.
UTM12S 461912E 3753649N
Elevation 5727ft. 1745m.
Habitat: Very sandy/rocky creekbed with evidence of high flow events
Assoc. spp: Veronica anagallis-aquatica, Herniaria cinerea, Cynodon dactylon, Acacia greggii, Cryptantha, Platanus wrightii, Calliandra eriophylla, Mimulus rubellus
Notes: Medium specimen of M. guttatus; Flowers yellow; annual; stems squarish
Theresa Price 806
21 April 2007
with: Kelly Steele
Arizona State University Herbarium (ASU)
ASU Vascular Plant Herbarium
Specimen Image Number
ASU0087129

Figure 6. *Erythranthe cordata*. Gila Co., Arizona, 21 Apr 2007, *Price 806*, ASU. Larger plant ca. 25 cm tall.

Figure 7. *Erythranthe cordata*. Cochise Co., Arizona, 19 Mar 1975, *Reeves R2418*, ASU. Upper plants decumbent at base and producing adventitious roots.

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copyright reserved
ASU
PLANTS OF THE SANTA TERESA MOUNTAINS
GRAHAM COUNTY, ARIZONA
ARIZONA STATE UNIVERSITY
Mimulus guttatus DC
Family: Scrophulariaceae
Det. by: J. Jeremy Buegge
Loc: Coronado National Forest
Elev: 4000 ft.
Fisher Canyon. T6S,R21E,sec8,SE,NW. UTM: 12N, 0572934E, 3642905N.
Habitat: Desert grassland. Near wash. S aspect. Gentle slopes. Red granite rock with gravely soil. Water flowing.
Other spp.: *Yucca baccata, Baccharis sarothroides, Mulenbergia rigens, Mimosa biuncifera, Juniperus monosperma, Ericameria laricifolia, Gutierrezia, Quercus turb*
Notes: Common. Annual (?) often in large clumps. Stolons but no rhizomes. Petals ylw, red spots, throat closed. Calyx ribbed in fruit.
Collector/number: J. Jeremy Buegge - 714
10 April 1999
with: A. Trauth-Nare
ASU Vascular Plant Herbarium
Specimen Image Number
ASU0087128

Figure 8. *Erythranthe cordata*. Graham Co., Arizona, 10 Apr 1999, *Buegge 714*, ASU. Plants apparently with rhizome-like bases but, with reference to the autogamous flowers, these inferred to have begun as above-ground stems. Also see collector's label notes: "Annual (?) often in large clumps. Stolons but no rhizomes."

Figure 9. *Erythranthe cordata*. Maricopa Co., Arizona, 14 Mar 1965, *Lehto 4552*, ASU. Fistulose stems with adventitious roots at nodes.

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copyright reserved
ASU
PLANTS OF ARIZONA
Arizona State University
Mimulus guttatus DC.
Maricopa County: Tonto National Forest..
Along Verde River at mouth of Camp Creek Wash.
FS 20, ca. 3 mi N of Rio Verde Road. 33°46.30'N, 111°39.9'W
Along slopes near river and along wash.
Annual herb near water.
°G. Walters, S. Palmer
L. R. Landrum 9640
With A. Trauth, A. Mejia, R. Puente, °
Fam: Scrop Elev: 1520 ft. Date: 16 Feb 2000
ASU Vascular Plant Herbarium
Specimen Image Number
ASU0087127
PHOENIX FLORA

Figure 10. *Erythranthe cordata*. Maricopa Co., Arizona, 16 Feb 2000, *Landrum 9640*, ASU. Without basal parts but label notes say "Annual herbs." Flowers autogamous.

ACKNOWLEDGEMENTS

I am grateful to the staff at herbarium ASU (Arizona State University) for their hospitality, particularly to Walter Fertig for providing the photos of specimens and to Liz Makings for the photo in Figure 1.

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IMAGING VENATION OF BROADLEAF PLANTS USING DSLR CAMERAS, TRASMITTED LIGHT, AND DIGITAL FILTERS

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ABSTRACT

Methods are outlined for obtaining high-quality digital images of venation in broadleaf plants using a DSLR camera, transmitted light, and digital filters (including edge detection filters). Mounted specimens can be imaged using an external flash placed beneath the specimen. This technique can be used on type specimens or rare collections when destructive sampling is not possible. Also outlined here is a common method used by botanists and nature photographers for using a handheld camera and transmitted sunlight to capture venation details in the field. Step-by-step instructions are given for these methods, and examples are provided with detailed notes on camera settings and digital filters. These techniques are not new, but neither are they often implemented in literature dealing with venation, likely because the standard protocol of chemically clearing and staining leaves provides the highest level of detail. However, the methods explained here usually show three or four orders of venation, which should prove useful in various taxonomic and ecological studies of broadleaf plants.

The Manual of Leaf Architecture (Ellis et al. 2009) makes a compelling case for the use of venation characters in taxonomic descriptions of broadleaf angiosperms, but there are also important paleoecological reasons to study venation. Boyce et al. (2009) show that among vascular plants, both modern angiosperms and fossil angiosperms have uniquely dense veins, a trait that allows higher transpiration rates and may help explain the modern dominance of angiosperms. Leaf veins are also informative in studies of plant physiology and development (for a brief review see Blonder et al. 2012). In the traditional method of studying venation, leaves are chemically cleared and stained, a type of preparation that is essential for observing the highest level of detail of most characters, especially under a microscope (see Vasco et al. 2014 for recent methods). But cleared leaf photographs are often left out of literature on modern plants such as guides to floras or descriptions of new species. Perhaps this has something to do with the time and materials involved in preparing the leaves or possibly the aesthetic challenges of photographing cleared specimens, since they have to be mounted in transparent material or floated in ethanol (Vasco et al. 2014). Additionally, the leaves of many species often break apart under chemical treatment (Blonder 2012).

When a leaf is backlit, the high transmission of visible light through the vascular tissues of leaves (i.e., the veins), creates contrast with the other tissues (Fig. 1). Nature photographers often take advantage of this property of leaves, but floristic treatments often do not. There are notable exceptions. For example, Brooker and Nicholle (2013) wrote a guide to the leaves of *Eucalyptus* and relatives using field images taken with transmitted sunlight. They explain that one of the benefits of photographing living leaves is that the oil cells in *Eucalyptus* relatives are obscured in dried specimens. Also, Harms (2015) has briefly explained how to use artificial transmitted light to photograph venation in the genus *Evolvulus*. Major herbaria, on the other hand, have imaged millions of plant specimens using *incident* lighting. This type of lighting probably gives a very true-to-life representation of most details, with the notable exception of venation (Fig. 1). Blonder et al. (2012) showed that x-raying leaves, a quick and relatively non-destructive method, can produce high quality

imagery of leaf venation, though at a cost that might be prohibitive for some projects. There has also been research on the use of edge detection filters and similar algorithms to extract venation information from leaf images photographed with incident light (Cope et al. 2010; Sanjeev et al. 2012).

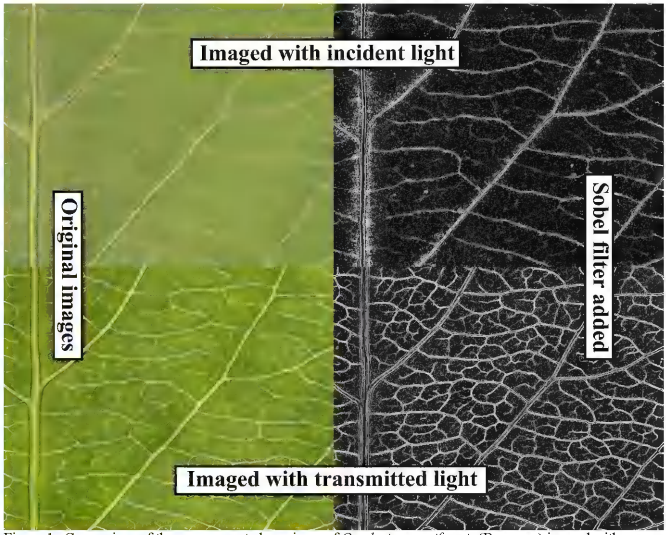

Figure 1. Comparison of the same mounted specimen of *Oemleria cerasiformis* (Rosaceae) imaged with incident light (top) and transmitted light (bottom). All camera settings and filters applied were identical for both sets of images. An external flash was used for both images. Sobel edge detection filters and grayscale applied in GIMP 2.8.

The methods described here are quick, non-destructive, and relatively inexpensive. In the examples provided (Figures 1, 4–10), three to four orders of veins are clearly discernable (sensu Ellis et al. 2009). These methods should not be considered a replacement for traditional clearing and staining methods but rather an alternative in situations when chemical treatment is impractical or impossible, as is the case with many type specimens or rare collections.

Equipment and techniques

The image quality of cropped-frame DSLRs works well for this type of imaging; however, full-frame sensor DSLRs usually have slightly better ISO to noise ratios. A macro lens is preferable, that is, a lens with a reproduction ratio greater than 1:1. The technique used for mounted specimens requires a tripod or herbarium imaging stand and an external flash or other strong lighting source that can be placed beneath the specimen. The external flash does not have to be able to meter with the camera; thus, a relatively inexpensive manual flash can be used. The light source should be strong

enough to pass through both the herbarium mounting paper and the leaf being photographed. Additionally, the side of the leaf specimen facing the camera can be important. All the examples given below feature the adaxial surface of the leaf facing the camera.

The images presented here as examples (Figures 1, 4–10) were taken using a Nikon D610 and Tokina 100 mm macro lens. Initial editing was done in Adobe Lightroom 5.6 and edge detection filters were applied in GIMP 2.8 (a free program) or Photoshop CC2014. Though the algorithm for Photoshop's Find Edges filter is not given, very similar results can be obtained by using GIMP's Differential filter set at 4 or 5 and with inverted colors. Edge detection filters can highlight some venation features and obscure others and so should be used with caution.

Technique for imaging mounted specimens using a tripod and artificial light (Figures 1–2, 4–8)

1. Create a platform that raises the mounted specimen approximately 0.3 m so that an external flash can be placed under the specimen. Place the external flash to one side of the leaf being photographed so that the illumination strikes the subject at approximately a 45° angle. This will help reduce glare from the flash. The position of the light source is very important and may require some experimentation depending on the equipment used. If light is concentrated too heavily in one area of the image, a diffuser may be needed. Mount the camera to a tripod, and position the camera directly over the specimen. A level may be required to align the camera with the specimen. Many herbaria are equipped with imaging stands that could be easily adapted to this method.
2. Switch camera to Manual mode and image quality to RAW.
3. Ideally, the ISO should be set as low as possible to reduce sensor noise (i.e., less than 400 on a full-frame camera and less than 100 on a cropped frame camera).
4. Shutter speed should be set somewhere between 1/20 and 1/150 (most cameras are not set up to exceed 1/200 while using a flash).
5. Aperture should be set depending on the lens, but 8 to 15 is usually a good range. Different lenses have different "sweet spots" of greater sharpness. An f-stop lower than 8, especially with a macro lens, will make it difficult to get the entire leaf plane in focus.
6. Perform test shots to find the right combination of shutter speed, aperture, and ISO.
7. Recommended: a bright incident light source such as a flashlight will help when focusing the lens manually.

Field photography technique with handheld camera and natural light (Figures 3, 9–10)

1. Set camera image size to RAW or highest resolution JPEG (if camera memory is an issue).
2. Set ISO from 100 to 1000, f-stop from 8 to 15, and shutter speed from 1/200 to 1/800. Optimal settings will depend on the amount of sunlight available.
3. Select a leaf specimen that is free of dirt and insect damage and that has a relatively flat plane.
4. Position the leaf with sunlight evenly back-lighting the area of interest. Also, position the subject so that an area directly behind it is in relative darkness (e.g., dense shrubs). Avoid allowing the light source to enter directly into the lens, as this will create ≡ glare in the image.
5. Perform test shots and adjust camera settings (primarily shutter speed, aperture, and ISO) accordingly so that the leaf is properly exposed but the background is dark. The background does not have to be completely dark since shadows can be exaggerated, i.e., turned into blackness using digital filters.

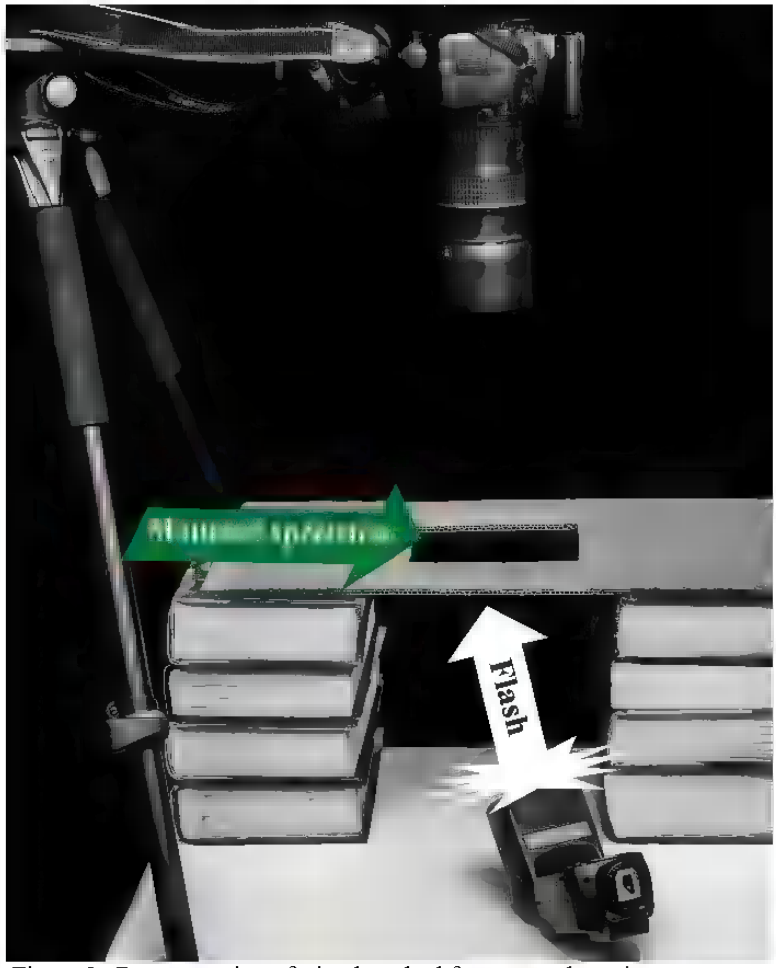

Figure 2. Demonstration of tripod method for mounted specimens.

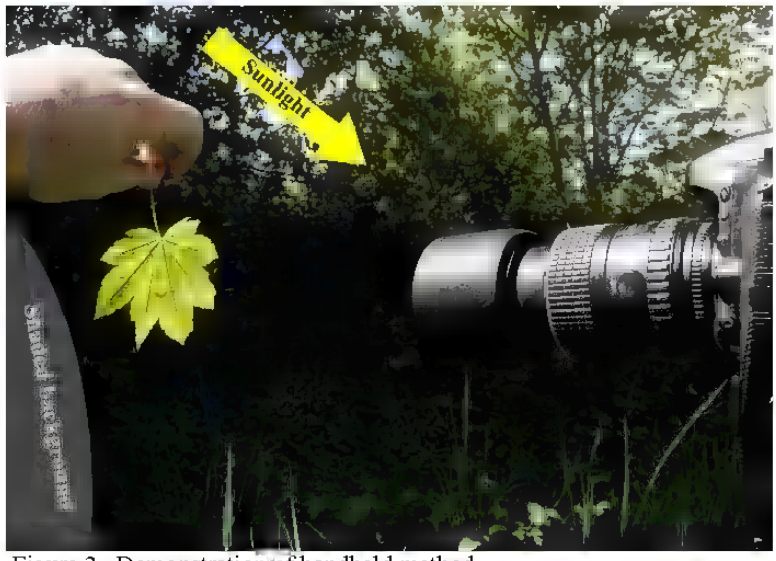

Figure 3. Demonstration of handheld method.

Image processing in Adobe Lightroom and GIMP (Figure 4)

1. Recommended: apply Black & White filter.
2. Generally, Contrast and Sharpness should be increased.
3. Apply a noise reduction filter (Luminance Smoothing), especially if cropping the image.
4. Adjust Exposure, Highlights, and Shadows so that venation is visible. Adjusting for a completely black or white background is not necessary but tends to hide noise artifacts in the background.
5. Use the manual Adjustment Brush tool to fix uneven exposure dark spots on the herbarium mounting paper. Photographs of living specimens may require more of these localized exposure adjustments since they are often more textured than pressed specimens.
6. Optional: apply a digital edge detection filter in Photoshop or GIMP.

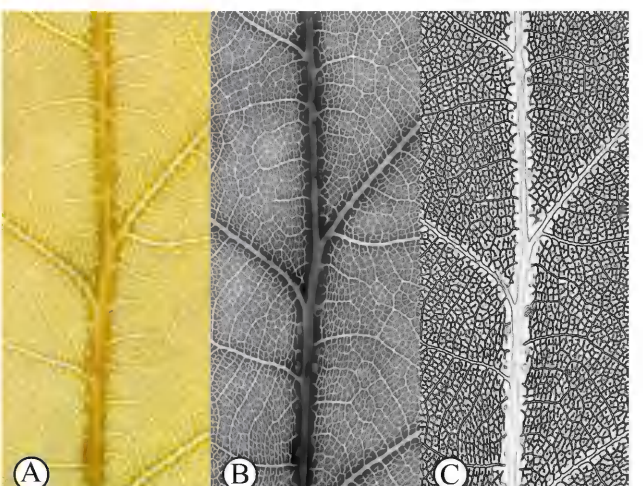

Figure 4. The same images of a mounted specimen of *Quercus robur* (Fagaceae) with various levels of filtering applied. All the images have noise reduction added in Lightroom. **A.** Unedited image, i.e., as imported into Lightroom. **B.** Edited in Lightroom (Black & White, Contrast +60, Shadows +80, highlights -50, Clarity +50.) **C.** Image from previous with Find Edges added in Photoshop.

Figure 5. Mounted specimen of *Amelanchier alnifolia* (Rosaceae) photographed with Nikon D610, Tokina 100 mm lens, tripod, and Yongnuo 560 III speedlight at 1/2 illumination. ISO 200, f/11, 1/50 s. Edited in Adobe Lightroom 5.6 (Black & White, Exposure + 1.243, Contrast + 100, Highlights +55, Shadows -26, Whites +45, Clarity +71, Luminance Smoothing 39).

Figure 6. Mounted specimen of *Holodiscus discolor* (Rosaceae) photographed with Nikon D610, Tokina 100 mm lens, tripod, and Yongnuo 560 III speedlight at 1/2 illumination. ISO 320, f/9, 1/40 s. Edited in Adobe Lightroom 5.6 (Black & White, Exposure +1.07, Contrast +95, Highlights +90, Shadows -20, Whites +100, Blacks -43. Clarity +30, Luminance Smoothing 48).

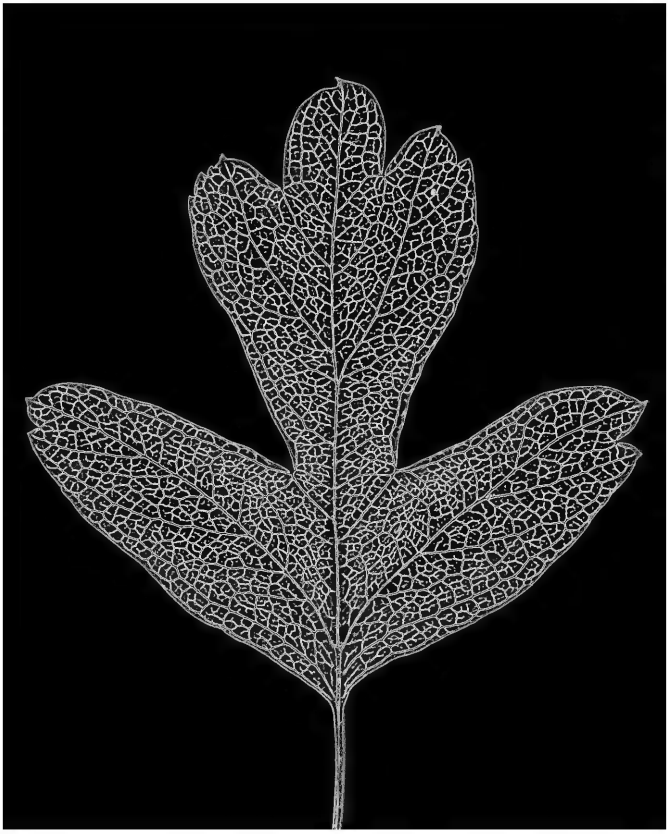

Figure 7. Mounted specimen of *Crataegus monogyna* (Rosaceae) photographed with Nikon D610, Tokina 100 mm lens, tripod, and Yongnuo 560 III speedlight at 1/2 illumination. ISO 320, f/9, 1/40 s. Edited in Adobe Lightroom 5.6 (Black & White, Exposure +1.9, Contrast +74, Highlights +50, Shadows -10, Whites +57, Blacks -60, Clarity +62, Luminance Smoothing 48). Sobel filter at setting 1 added in GIMP 2.8.

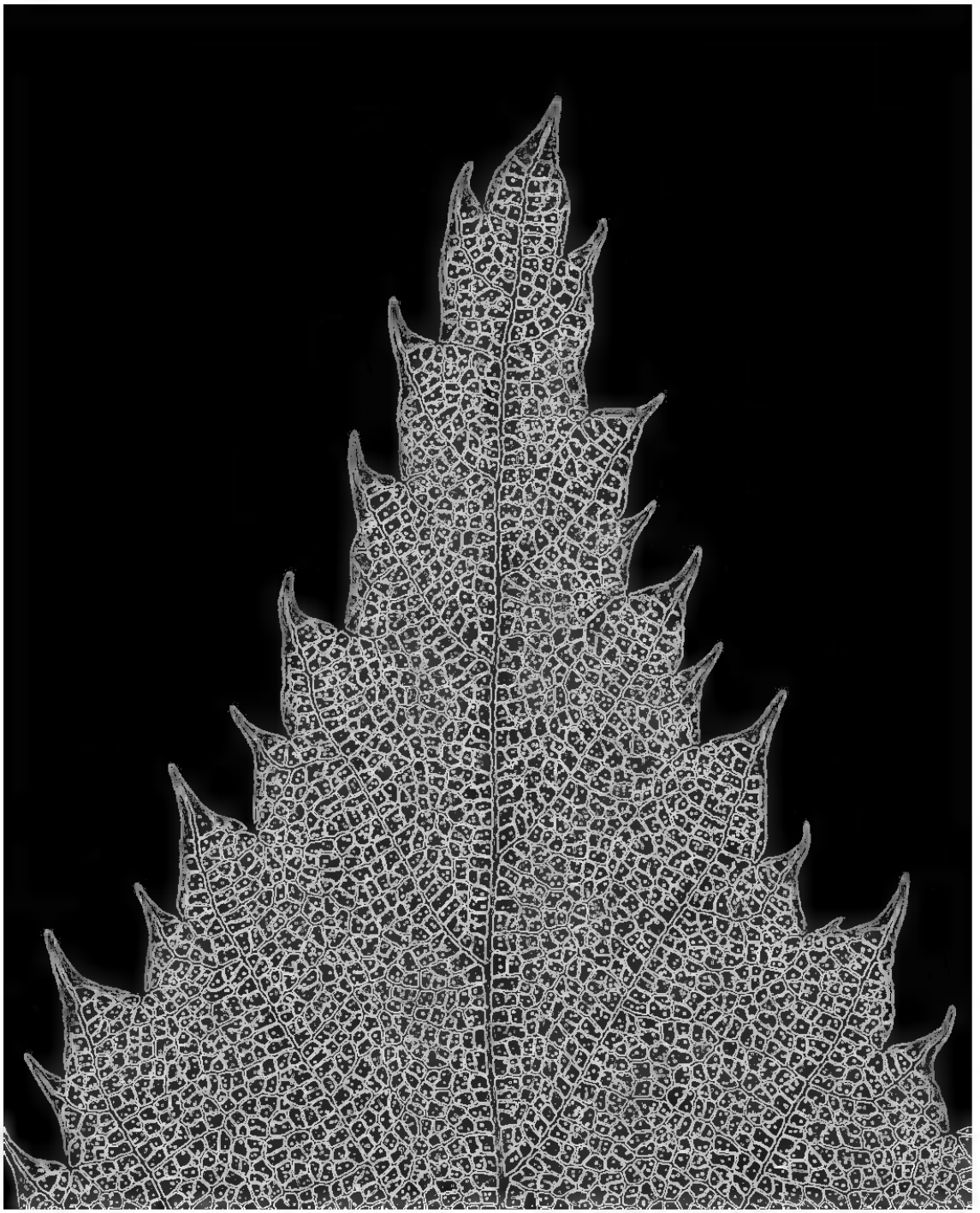

Figure 8. Mounted specimen of *Carpinus turczaninovii* (Betulaceae) photographed with Nikon D610, Tokina 100 mm lens, tripod, and Yongnuo 560 III speedlight at 1/2 illumination. ISO 320, f/14, 1/60 s. Edited in Adobe Lightroom 5.6 (Black & White, Exposure -1.2, Contrast +100, Highlights +12, Shadows +86, Whites 0, Blacks -60, Clarity +26, Luminance Smoothing 70). Sobel filter at setting 1 added in GIMP 2.8.

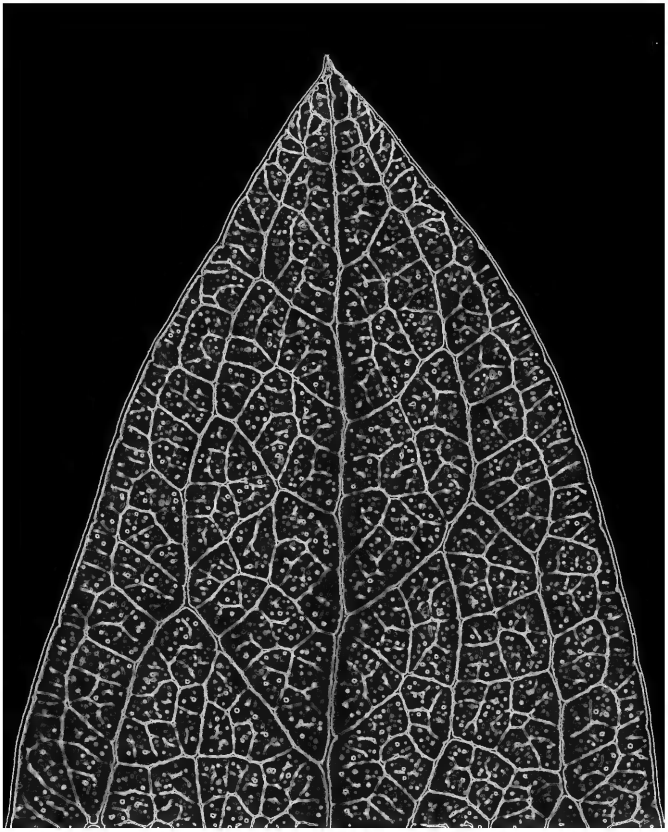

Figure 9. Living specimen of *Eucalyptus pauciflora* (Myrtaceae) photographed with handheld Nikon D610, Tokina 100 mm lens, and transmitted sunlight. ISO 1600, f/10, 1/640 s. Edited in Adobe Lightroom 5.6 (Black & White, Exposure -1.2, Contrast +100, Highlights +12, Shadows +86, Whites 0, Blacks -60, Clarity +26, Luminance Smoothing 70). Sobel filter at setting 1 added in GIMP 2.8.

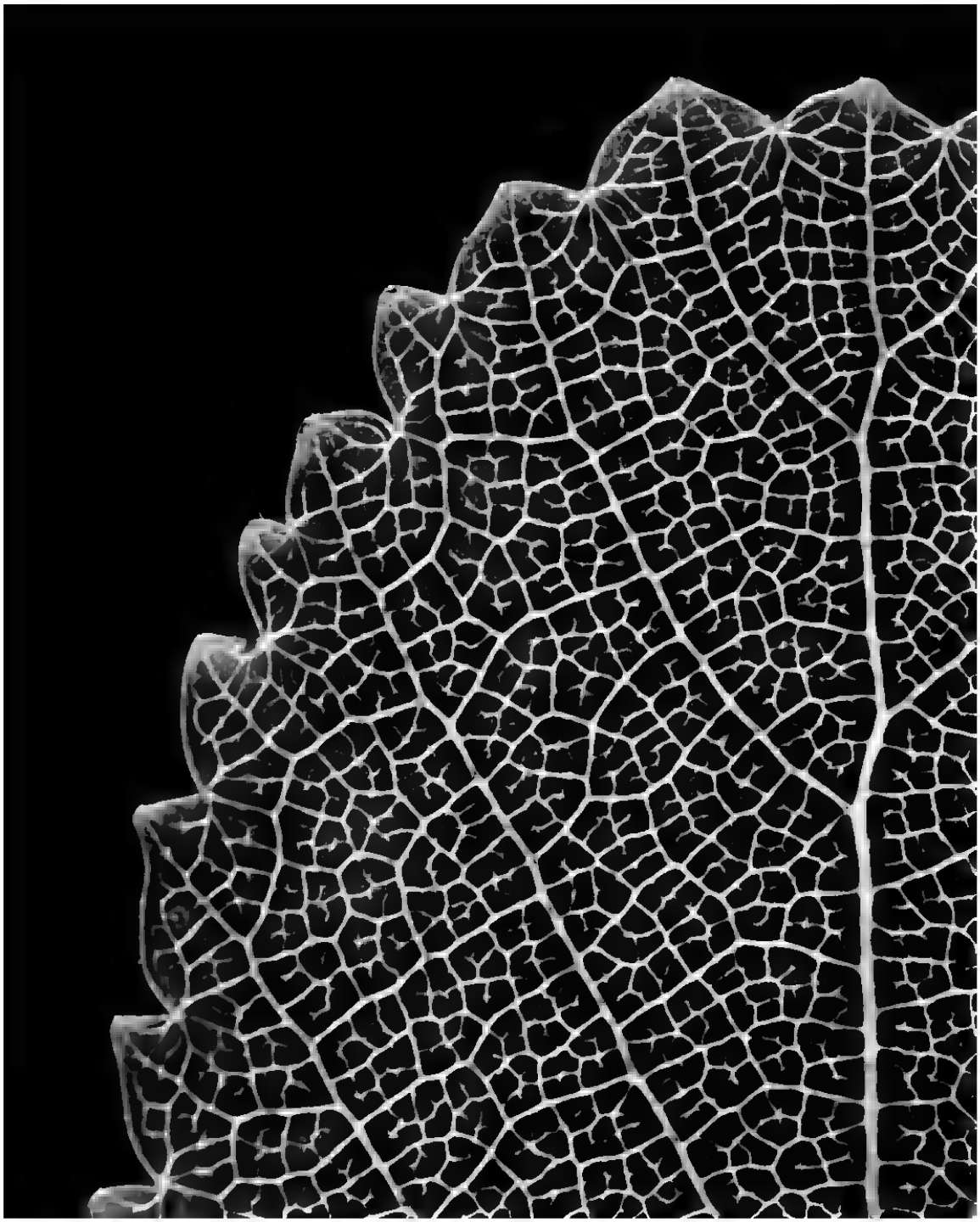

Figure 10. Living specimen of *Betula glandulosa* (Betulaceae) photographed with handheld Nikon D610, Tokina 100 mm lens, and transmitted sunlight. ISO 800, f/10, 1/800 s. Edited in Adobe Lightroom 5.6 (Black & White, Exposure -4.88, Contrast +38, Highlights -29, Shadows +29, Whites +74, Blacks -57, Clarity +81, Luminance Smoothing 73).

ACKOWLEDGMENTS

Support for this project was provided by a grant to the University of Southern Mississippi from the National Science Foundation (DBI 1203684). I would like to thank Mac Alford, Ann Shivers-McNair, and Brandon Morgan for offering helpful comments on this manuscript and Guy Nesom for reviewing and editing the final version.

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Published 18 June 2015. ISSN 2153 733X

SOLIDAGO BRENDIAE (ASTERACEAE: ASTEREAE) IN VERMONT

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ABSTRACT

A small-headed specimen originally identified as *Solidago canadensis* L. was collected in Granby, Vermont, in 1973. Recently, Gilman thought the specimen might be *S. brendiae* Semple and sent it to Semple for confirmation. The specimen was scored and compared with specimens of *S. brendiae*, *S. canadensis*, *S. fallax*, and *S. rupestris* in a set of multivariate analyses and was consistently placed a posteriori in *S. brendiae*, confirming Gilman's identification. This is the first report of *Solidago brendiae* from Vermont.

Four taxa of *Solidago* subsect. *Triplinerviae* (Torr. & A. Gray) Nesom have been reliably reported from Vermont: *S. altissima* L., *S. canadensis* L. var. *canadensis*, *S. canadensis* var. *hargeri* Fern., and *S. gigantea* Ait. (Gilman 2015). Reports of others were either of taxa now placed in synonymy by Semple (2008) — *S. gigantea* var. *leiophylla* Fern. (reported by Fernald 1950) and *S. gigantea* var. *serotina* (Kuntze) Cronq. (reported by Seymour 1969) — or were based on misidentified specimens: *S. altissima* subsp. *gilvocanescens* (Rydb.) Semple, identified as *S. canadensis* var. *gilvocanescens* Rydb. by Eggleston et al. (1915) and by Dole (1937).

In reviewing the collections at the Pringle Herbarium of the University of Vermont (VT), Gilman recently encountered a specimen, labeled and filed as *Solidago canadensis* L. that seemed to match the recently described *S. brendiae* Semple (Semple 2013).

USA: Vermont: Essex Co.: Granby, 30 Sep 1973, *B.H. Stearns s.n.* (VT, Figures 1-2).

The specimen had been collected in Essex County in northeastern Vermont, an area that lies at the southern edge of the North American boreal forest (Thompson & Sorenson 1999). As such, it is within the potential range of *S. brendiae*, so the specimen was forwarded for review to Semple, who determined it as that species and confirmed the identification using multivariate morphometric analyses. This is the first report of *Solidago brendiae* from Vermont.

Multivariate analyses to confirm identification of Stearns s.n. (VT)

Using the data and multivariate methods described in Semple et al. (2013, 2015), *Stearns s.n.* (VT) was compared with *Solidago brendiae* (28 specimens; only 19 in some analysis due to lack of data on several characters for nine specimens), *S. canadensis* (52 specimens), *S. fallax* (28 specimens) and *S. rupestris* (10 specimens). Although *S. rupestris* is not reported from further northeast than eastern Pennsylvania (the range included distantly scattered disjunct populations from Tennessee and Kentucky to the west and Maryland, Virginia, and Pennsylvania further east; Semple 2015, occasionally updated), the small heads of the species are similar in size to those of the collection by Stearns. One discriminant analysis was run including *S. rupestris* to confirm that the Vermont plant

Figure 1. *Solidago brendiae* from Granby, Vermont: *Stearns s.n.* (VT).

Figure 2. Details of *Solidago brendiae*, *Stearns s.n.* (VT). A. Lower stem. B. Mid stems. C. Stem in inflorescence. D. Upper stem leaf, adaxial surface. E. Upper stem leaf, adaxial surface, mid margin with small serrations. F. Lower inflorescence branch. G. Heads. Scale bars: = 1 mm in A-C and E-G; = 1 cm in D

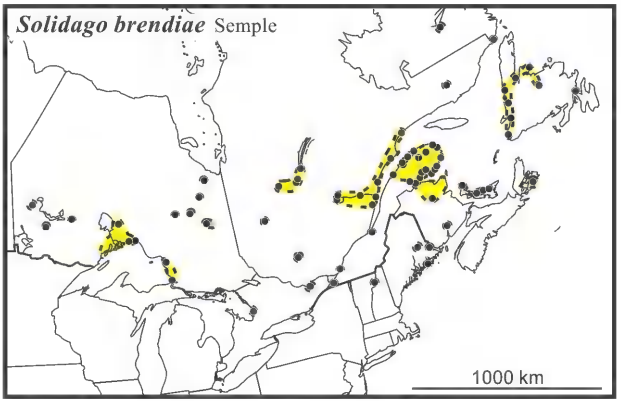

Figure 3. Distribution of *Solidago brendiae* based on all collections seen

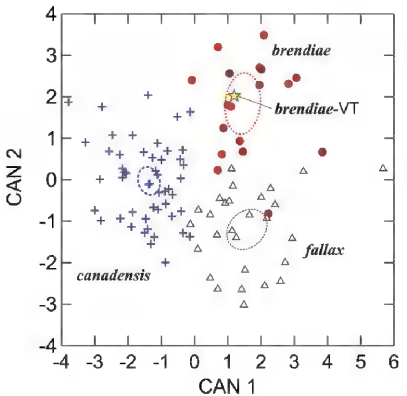

Figure 4. Two dimension plot of CAN1 versus CAN2 scores generated by the Canonical Analysis of specimens of the *Solidago brendiae*, *S. canadensis*, and *S. fallax*; 95% confidence ellipses are shown for each taxon; canonical placement of the *Stearns s.n.* (VT) from Vermont is indicated by a star.

was not a long-distant disjunct of that species. Two other analyses were run including just specimens of *S. brendiae*, *S. canadensis*, and *S. fallax*, which do or potentially might occur in northern Vermont and include specimens similar to *Stearns s.n.* In one analysis *Stearns s.n.* was not placed in an a priori group and only assigned to a group a posteriori. In the other analysis, *S. rupestris* was assigned a priori to the *S. brendiae* group.

Table 1. F-matrix for the discriminant analysis of three species groups: *S. brendiae*, *S. canadensis* and *S. fallax; Stearns s.n.* (VT) not assigned to an a priori group.

	brendiae	***canadensis***	***fallax***
brendiae	0.000		
canadensis	28.842	0.000	
fallax	14.122	30.007	0.000

Wilks' lambda = 0.2085 df = 5 2 105; Approx. F= 24.0358; df = 10 202; prob = 0.0000

Table 2. Results of the Classificatory Discriminant Analysis of three species-level groups *S. brendiae*, *S. canadensis* and *S. fallax*; *Stearns s.n.* (VT) and one *S. brendiae* specimen not assigned to an a priori group; cases in row categories classified into columns.

Classification matrix

	brendiae	***canadensis***	***fallax***	% correct
brendiae	25	1	0	96
canadensis	5	45	2	87
fallax	5	2	23	77
Total	35	48	25	86
Not Grouped	2	0	0	

Jackknifed classification matrix

	brendiae	***canadensis***	***fallax***	%correct
brendiae	25	1	0	96
canadensis	5	44	3	85
fallax	4	4	22	73
Total	34	49	25	84

Table 3. F-matrix for the discriminant analysis of three species groups: *S. brendiae*, *S. canadensis* and *S. fallax; Stearns s.n.* (VT) assigned to the *S. brendiae* a priori group; between groups F-matrix df = 7 90.

	brendiae	***canadensis***	***fallax***
brendiae	0.000		
canadensis	21.307	0.000	
fallax	14.064	24.462	0.000

Wilks' lambda = 0.1516 df = 7 2 96; Approx. F= 20.1675; df = 14 180; prob = 0.0000

Table 4. Results of the Classificatory Discriminant Analysis of three species-level groups *S. brendiae*, *S. canadensis* and *S. fallax*; *Stearns s.n.* (VT) assigned to the *S. brendiae* a priori group; cases in row categories classified into columns.

Classification matrix

	brendiae	***canadensis***	***fallax***	% correct
brendiae	17	0	2	89
canadensis	2	48	2	92
fallax	0	1	27	96
Total	19	49	31	93

Jackknifed classification matrix

	brendiae	***canadensis***	***fallax***	% correct
brendiae	17	0	2	89
canadensis	3	47	2	90
fallax	3	2	23	82
Total	23	49	27	88

In all three analyses, *Stearns s.n.* was placed a posteriori in the Classificatory Discriminant Analysis into *Solidago brendiae*. In the analysis including *S. rupestris*, *Stearns s.n.* was assigned a priori to *S. brendiae* and placed a posteriori into *S. brendiae* with 89% probability (11% probability to *S. canadensis*, and 0% to *S. fallax* and *S. rupestris*), The results of the analysis including *S. rupestris* are not discussed further.

In the analysis without *Solidago rupestris* and with *Stearns s.n.* not assigned to an a priori group, outer and inner phyllary length traits were not included in the analysis, which meant all 27 specimens of *S. brendiae* were included. The following traits were selected in the Stepwise Discriminant Analysis as strongest in separating the three a priori groups in order of decreasing F-to-remove values in parentheses: number of disc florets (14.14), number of ray florets (11.54), upper leaf length (10.56), mid leaf width at the widest point (10.53), and involucre height (8.30). Table 1 presents the F-matrix results and Table 2 presents the a posteriori Classification Matrix and Jackknife Classification Matrix results. *Stearns s.n.* was assigned a posteriori to *S. brendiae* and with 69% probability (23% probability to *S. canadensis*, and 8% to *S. fallax*).

In the analysis without *Solidago rupestris* and with *Stearns s.n.* assigned a priori to the *S. brendiae* group, outer and inner phyllary length traits were included in the analysis which meant only 19 specimens of *S. brendiae* were included. The following traits were selected in the STEPDISC analysis as strongest in separating the three a priori groups in order of decreasing F-to-remove values in parentheses: upper leaf length (18.21), number of ray florets (12.68), inner phyllary length (11.04), involucre height (6.64), upper leaf margin number of serrations (6.47), number of disc florets (12.32), disc floret lobe length (5.42). Table 3 presents the F-matrix results and Table 4 presents the a posteriori Classification Matrix and Jackknife Classification Matrix results. *Stearns s.n.* was placed a posteriori into *S. brendiae* with 99% probability (1% probability to *S. canadensis*, and 0% to *S. fallax*). The results of the canonical analysis (dimension reduction technique) are shown in Figure 3;

for clarity, the position of *Stearns s.n.* is shown by a yellow star which is nested within the 95% confidence limits ellipse of the *S. brendiae* group (red dots), to which it was assigned a priori.

Comments on *Stearns s.n.* (VT)

The circumstances of the Vermont collection are of interest. Frank C. Seymour, author of the Flora of Vermont, ed. 4 (Seymour 1969) was Associate Curator of the Pringle Herbarium. He was also associated with the Vermont Botanical and Bird Club, which in the early 1970's was preparing a new Check List of the Plants of Vermont (Atwood et al. 1973). In the interest of "filling in the blanks" by obtaining new county records, Seymour made numerous trips with students to under-collected areas of the state to collect voucher specimens for the Check List. *Solidago brendiae* was collected on one such trip, 30 September 1972. Seymour was careful to label specimens with their actual collector, and inspection of specimens at VT shows that students on the Granby trip included B.H. Stearns. R.D. Paul, and S.R. Bassett. Specimens collected by them or by Seymour himself in Granby on 30 September 1972 included at least the following (there may be others: a complete database of Vermont specimens at VT is not prepared as yet): *Abies balsamea*, *Acer saccharum*, *Actaea pachypoda*, *Agrimonia striata*, *Aralia racemosa*, *Betula alleghaniensis*, *Dichanthelium acuminatum* var. *implicatum*, *Diphasiastrum complanatum*, *Doellingeria umbellata*, *Eleocharis ovata*, *Fagus grandifolia*, *Galeopsis tetrahit* var. *bifida*, *Hypericum boreale*, *Hypericum perforatum*, *Juncus bufonius*, *Larix laricina*, *Lobelia inflata*, *Picea glauca*, *Pilosella aurantiaca*, *Prunella vulgaris* subsp. *lanceolata*, *Rubus idaeus* var. *strigosus*, *Scirpus cyperinus*, *Scirpus georgianus*, *Solidago rugosa*, *Sorbus americana*, *Spiraea alba* var. *latifolia*, *Spiraea tomentosa*, *Taraxacum officinale*, *Triadenum fraseri*, *Uvularia sessilifolia*, *Vaccinium myrtilloides*, *Veronica officinalis*, and *Zizia aurea*.

All of these species, with the exception of *Scirpus georgianus*, are very common plants in the region and throughout Vermont and give little clue to pinpointing an exact location within the township of Granby where *Solidago brendiae* may now occur. Any of them may have been collected on roadsides or adjacent forests. Granby has no paved roads but an extensive network of logging roads, and the forest products industry is the major economic activity. It is of typical areal size for Vermont towns (ca. 39 square miles) with a population of fewer than 100.

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LECTOTYPIFICATION OF *OPUNTIA BASILARIS* VAR. *WOODBURYI* (CACTACEAE)

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ABSTRACT

The material used for the recent lectotypification of *Opuntia basilaris* var. *woodburyi* consisted of a mixed collection and was thus invalid for use as a lectotype. We explain and correct the lectotypification of that taxon.

Opuntia basilaris Engelm. & J.M. Bigelow var. *woodburyi* W.H. Earle was described from Washington Co., Utah, by Earle (1980) as a new variety of the widespread species *O. basilaris*. However, in his publication Earle failed to designate an appropriate repository for the type specimen and stated that the holotype was both at ASU and DES. The type material also was composed of a mixed collection — seeds and a cladode from 3 Oct 1978 prepared by *Earle s.n.* and an immature fruit and four longitudinally dissected flowers collected on 26 May 1979 by *Woodbury s.n.*

Parfitt (1997) later described the new octoploid species *Opuntia pinkavae* B.D. Parfitt, and in his discussion of the taxon he noted that *O. basilaris* var. *woodburyi*, also an octoploid, was a nomenclatural synonym of the new species, although it had not been validly published as a result of Earle (1980) not clearly designating a repository.

Reveal (Pinkava 2012) realizing the error lectotypified material of *O. basilaris* var. *woodburyi*, but he failed to account for the mixed collection that had been used as the type, which also renders the taxon invalidly published as per Art. 8.2 of the code. Thus, *O. basilaris* var. *woodburyi* still needs to be properly lectotypified based on the vegetative material and mature seeds that were collected in 1978, the year of collection mentioned in the protologue. The mature seeds must have been collected in October of 1978, as fruit of the species do not ripen until July, according to Parfitt (1997); the flowers and immature fruit were collected in May of 1979 and should be excluded from the type.

Another specimen sometimes referred to as type material was collected by *L.A. Woodbury 2018* (BYU) from the same location on 16 May, 1978. However, neither this specimen nor BYU were cited in the protologue and thus cannot serve as the type for *O. basilaris* var. *woodburyi*. Duplicates of *Woodbury 2018* also have not been found at either ASU or DES, the two repositories noted in the protologue.

Opuntia basilaris Engelm. & J.M. Bigelow var. **woodburyi** W.H. Earle, Saguaroland Bull. 34: 15. 1980. **LECTOTYPE** (designated here): **UTAH**. Washington Co.: 16 mi S/SW of Hurricane on Fort Pierce Wash, elev. 3680 [ft], 3 Oct 1978, *W.H. Earle s.n.* (stem segment and mature seeds in packet, 108725, barcode ASU0019063, ASU!; isolectotype: stem segment and mature seeds in packet, 18161, barcode DES00078164, DES!; see Fig. 1).

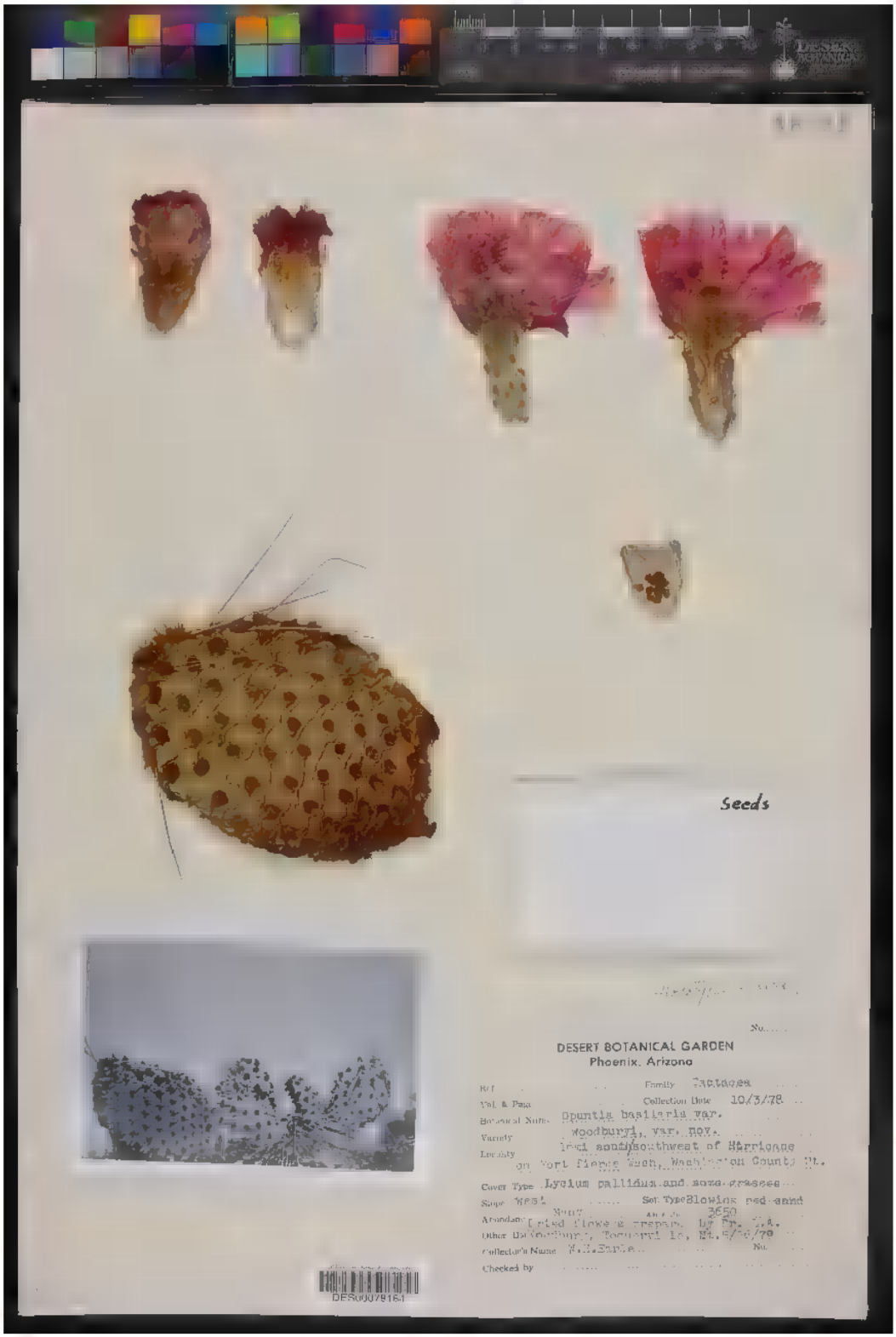

Fig. 1. Isolectotype of *O. basilaris* var. *woodburyi*. The longitudinally cut flowers and immature fruit present on the sheet are excluded from the isolectotype.

ACKNOWLEDGEMENTS

We would like to thank Walter S. Judd for comments on an earlier version of the manuscript.

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TAXONOMY OF *GALACTIA* (FABACEAE) IN THE USA

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ABSTRACT

Galactia in the USA includes 21 species; 13 of these occur in Florida but only 3 are strictly endemic to the state; 9 occur in Texas. *Galactia regularis* (L.) B.S.P. is the species widespread across the eastern USA with twining stems, broadly elliptic leaflets, and relatively small flowers, while *G. volubilis* (L.) Britt. (with *G. macreei* M.A. Curtis and *G. glabella* Michx. as synonyms) is the mostly coastal plain species with twining stems but narrower leaflets and larger flowers — this application of *G. regularis* and *G. volubilis* essentially agrees with W.H. Duncan' assessment in 1979. *Galactia brachypoda* Torr. & Gray is the correct name for the widespread Atlantic coast species with procumbent (mostly non-twining) stems and relatively large flowers. *Galactia grisebachii* Urb. is interpreted here as the name of the twining, linear-leaflet plants of southmost Florida previously identified as *G. parvifolia* A. Rich. **Galactia joselyniae** Nesom, **sp. nov.**, occurs in Brewster and Jeff Davis counties, Texas, and in Coahuila, Mexico. Lectotypes are designated for *Galactia canescens* Benth., *Galactia floridana* var. *longeracemosa* Vail, *Galactia prostrata* Small, *Galactia sessiliflora* Torr. & Gray, *Galactia stenophylla* Urb., and *Glycine striata* Jacq. A key to species is provided, as well as a typification summary, brief morphological and ecological description, and county-level distribution map for each species.

Galactia P. Browne (Phaseoleae, Diocleinae) is estimated here to include at least 111 species (see tally in Appendix, provided here because of significant underestimates in previous accounts), most native to the Americas, distributed among South America, Central America, West Indies, Mexico, and the southeastern and south-central USA, with the greatest concentrations in South America and the USA. Diversity in the USA is concentrated in Florida and in Texas. Four *Galactia* species are native to Asia, Australia, and Africa, including *G. tenuiflora* (Willd.) Wight & Arn., which apparently occurs natively in all three areas. Chen et al. (2010) described the range of *G. temuiflora* as southern China, Taiwan, India, Malaysia, Philippines, Sri Lanka, Thailand, Vietnam, and Africa. *Galactia tashiroi* Maxim. is endemic to Taiwan and the Ryukyu Islands of Japan.

Taxonomic studies of *Galactia* have been completed relatively recently for Argentina and neighboring countries (Burkart 1971), Venezuela (Torres et al. 1983), Brazil (Ceolin 2011; Ceolin & Miotto 2013), and Cuba (Beyra Matos et al. 2005) and various regional floras have included substantial numbers of species. In the USA, the first study devoted solely to *Galactia* was by Vail (1895), who included 14 species. Small (1933) included 14 species for the southeastern USA; Duncan (1979) recognized 8 for the same area. Ward and Hall (2004) recognized 11 species for Florida, and Isely's overview (1998) for the USA included 17. Significant disagreement over species concepts and nomenclature has characterized the USA studies — Isely in 1998 (p. 563) noted that "Herbarium annotations remain author-idiosyncratic and chaotic."

Galactia encompasses a wide diversity of habit, root and rhizome structure, leaf venation, inflorescence structure, and floral morphology. It is characterized by the following features: plants herbaceous perennials, mostly procumbent to sprawling or twining-climbing vines, less commonly erect; leaves mostly 1- or 3-foliolate, less commonly 5–7(–9)-foliolate (imparipinnate); flowers in axillary and/or terminal "pseudoracemes" or "racemoid panicles," each flower with 1 bract and 2 bracteoles (Tucker 1987, 2003; Prenner 2012); calyces 4-lobed, two upper lobes fused into one; corollas red to purplish, pink, bluish, or white; stamens diadelphous or pseudomonadelphous, with the

vexillary stamen free or connate from middle downward; and ovaries sessile to stipitate, fruits dehiscent, with seeds transverse to oblique in the fruit.

Burkart (1971) recognized three sections within *Galactia*, emphasizing the South American species. Most *Galactia* species, including all of those in the USA and treated in the study, are placed in sect. *Odonia* sensu Burkart.

Sect. **Galactia** TYPE: *G. pendula* Pers., West Indies

Vines, without rhizomes. Leaves 3-foliolate. Corollas 16–26 mm long, glabrous, petals narrow. Stamens diadelphous. Burkart recognized *G. lindenii* Burkart from Colombia also as a member of sect. *Galactia*; various other West Indian species apparently also would be placed here, at least technically, following Urban's key (1900), e.g., *G. rubra* Urb., which has long corollas with red petals, like *G. pendula*.

Sect. **Odonia** (Bertol.) Burkart TYPE: *Odonia tomentosa* Bertol., a synonym of *G. striata*
Odonia Bertol.

Procumbent to climbing vines, or erect; rhizomes present or absent. Leaves 1-, 3-, or 5–7(–9)-foliolate. Corollas most less than 16 mm long, glabrous, petals relatively broader. Stamens diadelphous with vexillary stamen free, rarely pseudomonadelphous with vexillary stamen connate from middle downward.

Sect. **Collaearia** (Benth.) Burkart TYPE: *G. peduncularis* (Benth.) Taub.
Collaea sect. *Collaearia* Benth.

Erect subshrubs, rarely viney; rhizomes present, lignescent. Leaves 1- or 3-foliolate. Corollas mostly less than 16 mm long, standard sericeous on outer surface, petals relatively wide. Stamens often pseudomonadelphous (approaching the genus *Camptosema* Hook. & Arn.). Burkart recognized 13 species in sect. *Collaearia*, mainly from Brazil.

Galactia forms a group in the subtribe Diocleinae together with 3 or 4 other genera: *Camptosema* Hook. & Arn. (10 species, South America), *Lackeya* Fortunato et al. (1 species, USA; Maxwell 1979; Fortunato et al. 1996), and *Collaea* DC. (7 species, South America; Fortunato 1995; Ceolin & Miotto 2009). Maxwell & Taylor (2003) included the Caribbean *Rhodopis* Urb. (2 species; Judd 1984) in their *Galactia* clade. Preliminary phylogenetic studies indicate that *Galactia* is not monophyletic (Queiroz et al. 2003; Sede et al. 2008, 2009; Ceolin 2011), but relatively few species have yet been included in analyses. Tentatively, *Galactia* appears to be paraphyletic without the inclusion of some *Camptosema* species and perhaps the whole genus *Collaea*. Also, tentatively, Burkart's sections do not appear to be monophyletic.

Maxwell (1979) transferred the eastern North American *Dioclea multiflora* (Torr. & Gray) C. Mohr into *Galactia*; Fortunato et al. (1996) segregated *D. multiflora* as the monospecific genus *Lackeya*. This species apparently has not yet been included in molecular-phylogenetic analyses but it appears to be morphologically out of place in *Galactia*.

GALACTIA P. Browne, Civ. Nat. Hist. Jamaica, 298. 1756. **TYPE**: *Galactia pendula* Pers.

Derivation: Greek, *galaktos*, milk; alluding to the "milky" branches of the original species, (*Galactia pendula* Pers. 1807 = *Clitoria galactia* L.). Referring to the earlier phrase name ("Phaseolus minor lactescens") in Hans Sloane's catalogue of Jamaican plants, Browne noted that this plant "is easily distinguished by its long reddish flowers, **milky branches**, and smooth leaves." The stems of *G. pendula* and some other species apparently produce a milky sap, but none of those in the USA do so.

Heterocarpaea Scheele, Linnaea 21: 467. 1848. **TYPE**: *H. texana* Scheele (= *Galactia texana*).
Odonia Bertoloni, Lucubr. Herb., 35. 1822. **TYPE**: *O. tomentosa* Bertoloni (= *Galactia striata*).

Perennial herbs [subshrubs, rarely shrubs], from rhizomes, an elongate taproot, or a fusiform taproot. **Stems** procumbent or twining and climbing. **Leaves** mostly 1- or 3-foliolate, less commonly 5-foliolate or 7(–9)-foliolate; stipules small, deciduous or persistent; stipels persistent. **Inflorescences** pseudoracemes, axillary [terminal], pedunculate or without an axis and flowers in axillary fascicles, sometimes axillary and of a single flower; rachis with slightly swollen nodes; bracts small, setaceous; bracteoles minute. **Flowers** pedicellate, solitary, paired, or in fascicles of 2–3 at rachis nodes, axillary when peduncle and rachis absent; each flower with 1 bract and 2 bracteoles, deltoid, lanceolate or subulate. **Calyx** campanulate, lobes 5 appearing as 4 (upper 2 comletely connate), linear to lanceolate, longer than the tube, lateral slightly smaller, lowest often longest. **Corolla** purplish to bluish or pink [red]; petals subequal in length; banner orbicular to ovate or obovate-orbicular, margin slightly inflexed or appendaged, apex rounded; wings narrow or obovate, adherent to keel; keel obtuse and almost straight, subequal to or longer than wings. **Stamens** 10, diadelphous [pseudomonadelphous]; vexillary stamen free or connate from middle downward. **Ovary** subsessile; style filiform, glabrous; stigma small, capitate, terminal; nectary at ovary base. **Legumes** linear, laterally compressed, straight or weakly to strongly falcate, with false septae between seeds, elastically dehiscent. **Seeds** 1–12, estrophiolate. **Base chromosome number**, x = 10.

Ca. 111 species — see accounting in APPENDIX (21 in the USA): native to the USA, Mexico, Central America, West Indies, South America, Africa, Asia, Australia.

KEY TO SPECIES OF TEXAS, NEW MEXICO, AND ARIZONA

1. Leaflets 1 ..... 1. **Galactia marginalis**
1. Leaflets 5 or 3.

2. Leaflets 5 ..... 3. **Galactia heterophylla**
2. Leaflets 3.

3. Stems erect, not twining, usually alternately bent at nodes; inflorescence subsessile, 1–6-flowered ..... 15. **Galactia erecta**
3. Stems procumbent or twining-climbing; inflorescence pedunculate, 1-flowered if sessile or subsessile.

4. Stems procumbent, not twining, commonly producing filiform rhizomes at the nodes, these producing subterranean flowers and 1-seeded fruits ..... 18. **Galactia canescens**
4. Stems climbing-twining or at least proximally prostrate then distally twining, without rhizomes at nodes, without subterranean flowers and fruits.

5. Stems at least proximally procumbent, sometimes then distally twining.

6. Leaflets broadly oblong to suborbicular; flowers flowers solitary and axillary or 2–8 in a pseudoraceme, corollas 6–8 mm long ..... 16. **Galactia joselyniae**
6. Leaflets oblong-elliptic to elliptic-ovate; flowers (2–)5–18(–30) in a pseudoraceme, corollas 11–12 mm long ..... 17. **Galactia wrightii**

5. Stems usually climbing, twining proximally and distally.

7. Flowers 1–5, solitary and pedicellate or 2–5 on inflorescence axis 1–12(–40) mm; fruits falcate ..... 19. **Galactia texana**
7. Flowers 1–8(–16), solitary and pedicellate or 2–8(–16) on inflorescence axis 10–150(–280) mm; fruits straight.

11. Leaflets narrowly oblong to oblong-lanceolate, 25–75 mm x 6–14 mm; fruits 35–65 mm long, seeds 12–15 ..... 12. **Galactia longifolia**
11. Leaflets as below, (10–)12–40(–50) mm x 5–21(–25) mm; seeds 5–11.

12. Leaflets mostly elliptic to broadly elliptic, (5–)10–21(–25) mm wide; stems moderately to densely hirsute to hirsute-villous with spreading-deflexed hairs ..... 13. **Galactia regularis**
12. Leaflets mostly oblong to lanceolate-oblong, 5–15(–17) mm wide; stems sparsely to moderately strigose with tightly to loosely appressed, retrorse hairs, sometime glabrate..... 14. **Galactia volubilis**

KEY TO SPECIES OF THE USA

1. Leaflets 1 ..... 1. **Galactia marginalis**
1. Leaflets 3 or 5–3.

2. Leaflets 5–9

3. Leaflets 5–9; flowers white, 3–11 and distally positioned on the inflorescence axis; Florida, Georgia, South Carolina ..... 2. **Galactia elliottii**
3. Leaflets 5; flowers pink to purple, purple-red, or deep lavender, solitary and axillary; Texas ..... 3. **Galactia heterophylla**

2. Leaflets 3.

4. Stems mostly erect, not twining, usually alternately bent at nodes; inflorescence subsessile, 1–6-flowered ..... 15. **Galactia erecta**
4. Stems procumbent or climbing-twining, not bent at nodes; inflorescence pedunculate, 1-flowered if sessile or subsessile.

5. Stems procumbent at least proximally and not twining, twining or weakly twining distally in some.

6. Plants commonly producing filiform rhizomes at the nodes, these producing subterranean flowers and 1-seeded fruits ..... 18. **Galactia canescens**
6. Plants without rhizomes at nodes, without subterranean flowers and fruits.

7. Calyx lobes brown to reddish brown on inner surface when dry; corollas distinctly dark reddish when dry, persisting after withering, sometimes still present when fruit is mature ..... 6. **Galactia mollis**
7. Calyx lobes greenish-yellow to tan on inner surface when dry; corollas light whitish to blue, pinkish, or purplish when dry, not persisting after anthesis.

8. Leaflets subcoriaceous to coriaceous, venation raised on both surfaces.

9. Leaflets mostly linear-oblong or narrowly oblong, 2–8(–11) mm wide; Florida only ..... 15. **Galactia pinetorum**
9. Leaflets elliptic, oblanceolate-elliptic, oblong-elliptic, elliptic-lanceolate, or broadly lanceolate, (4–)7–25(–32) mm wide; Florida, Alabama, Georgia, South Carolina, North Carolina, Virginia.

10. Internodes only a little longer to usually shorter than the largest leaflet of adjacent nodes, hairs on stems 0.05–0.25 mm long; leaflets (4–)7–10(–18) mm wide; flowers solitary and axillary or 2–4 ..... 7. **Galactia minor**
10. Several to most internodes (especially those toward the base) longer than the largest leaflet of adjacent nodes, hairs on the stem 0.1–0.8 mm long; leaflets (4–)10–25(–32) mm wide; flowers (3–)5–15(–25), rarely 1–2 ..... 8. **Galactia brachypoda**

8. Leaflets herbaceous, venation not raised.

11. Stems loosely strigose; Texas, New Mexico, and Arizona.

12. Leaflets broadly oblong to suborbicular; flowers flowers solitary and axillary or 2–8, corollas 6–8 mm ..... 16. **Galactia joselyniae**
12. Leaflets oblong-elliptic to elliptic-ovate; flowers (2–)5–18(–30), corollas 11–12 mm ..... 17. **Galactia wrightii**

11. Stems tomentose to hirsute-villous or hirsute; se USA.

13. Leaflets (14–)20–55 x (10–)15–35 mm; flowers 5–12(–25) 9. **Galactia floridana**
13. Leaflets 8–30 x 5–20 mm; flowers solitary and axillary or 2–6.

14. Inflorescence axis (5–)20–60(–90) mm; calyces 6–7 mm; corollas 12–15 mm; southern Florida ..... 10. **Galactia smallii**
14. Inflorescence axis 10–20 mm; calyces 3–4 mm; corollas 6–7 mm; panhandle Florida and adjacent southern Alabama ..... 11. **Galactia microphylla**

5. Stems climbing or sprawling, twining.

15. Corollas 11–14(–15) mm; stems loosely strigose with short, loosely appressed, retrorse hairs, strongly lignescent ..... 5. **Galactia fasciculata**
15. Corollas 7–11 mm; stems strigose to hirsute or hirsute-pilose, herbaceous to weakly lignescent or (*G. striata*) strongly lignescent.

16. Banner striped with white lines; localities coastal and near-coastal . 4. **Galactia striata**
16. Banner not striped; localities inland to coastal.

17. Fruits falcate; flowers 1–5, solitary and pedicellate or 2–5 on inflorescence axis 1–4(–40) mm ..... 19. **Galactia texana**
17. Fruits straight; flowers 1–8(–16), solitary and pedicellate or 2–8(–16) on inflorescence axis 10–150(–280) mm.

18. Stems strigose with antrorse hairs; leaflets linear-oblong to narrowly oblong or narrowly elliptic, 2–4(–6) mm wide; Florida only ..... 21. **Galactia grisebachii**
18. Stems strigose to hirsute or hirsute-villous with spreading-deflexed to retrorse hairs; leaflets oblong to elliptic or lanceolate, 5–21(–25) mm wide; Texas only or broadly distributed in the se USA.

19. Leaflets narrowly oblong to oblong-lanceolate, 6–14 mm wide; fruits 35–65 mm long, seeds 12–15; Texas only ..... 12. **Galactia longifolia**
19. Leaflets as below, 5–21(–25) mm wide; seeds 5–11; se USA including Texas.

20. Leaflets mostly elliptic to broadly elliptic, (5–)10–21(–25) mm wide; stems moderately to densely hirsute to hirsute-villous with spreading-deflexed hairs; corollas 7–10 mm ..... 13. **Galactia regularis**
20. Leaflets mostly oblong to lanceolate-oblong, 5–15(–17) mm wide; stems moderately to sparsely strigose with tightly to loosely appressed, retrorse hairs, sometime glabrate; corollas 9–14 mm 14. **Galactia volubilis**

1. **GALACTIA MARGINALIS** Benth., Ann. Wiener Mus. Naturgesch. 2: 126. 1838. **LECTOTYPE** (Burkart 1971, p. 717): **USA. Texas**. No other data, *T. Drummond 145* (US [ex herb. Univ. Lausanne] digital image!; isolectotype: W digital image!). Bentham cited "In Mexico Karwinsky. -- Texas, Drummond." The lectotype chosen by Burkart is a tiny plant with only two leaves, perhaps just a fragment of a fuller specimen at LAU.

Cologania heterophylla Gillies ex Hook., Bot. Misc. 3: 181. 1833. *Galactia heterophylla* (Gillies ex Hook.) Vail, Bull. Torrey Bot. Club 22: 502. 1895 [nom. illeg., preceded by *Galactia heterophylla* A. Gray 1850]. **LECTOTYPE** (Burkart 1971, p. 750): **ARGENTINA. [Córdoba.]** El Rio Cuarto, W side Las Pampas, [ca. 1820], *J. Gillies s.n.* (K 502879 digital image!; isolectotype: E digital image!). Also cited was "Monte Video, Tweedie" — this specimen apparently mounted on the same sheet as the lectotype.

Perennial herbs, arising from a short, ovoid-fusiform tuber sometimes producing slender rhizomes or rhizome-like caudex branches from the apex. **Stems** procumbent, not twining, lignescent, sparsely to moderately short-strigose with retrorse hairs. **Leaflets** 1, blades narrowly elliptic to narrowly lanceolate, 25–85 x 4–10(–16) mm, coriaceous, not glaucous abaxially, completely glabrous, veins closely reticulate and strongly raised, thickened marginal vein completely encircling the whole margin, apices rounded to obtuse. **Inflorescence** of axillary, solitary flowers. **Calyces** 5–6 mm, short-strigose. **Corollas** 13–15 mm, pink to purple, purple-red, or deep lavender. **Fruits** 25–35 mm x 5–7 mm, straight, short-strigose with closely appressed hairs. **Seeds** (5–)7–9.

Flowering (Feb–)Apr–Oct. Oak-juniper woodland, blackjack-post oak woods, coastal prairie, sand, sandy loam, gravelly hillsides, ditch banks; 2–200 m; Tex.; Mexico (Coahuila, Tamaulipas); South America (Argentina, Brazil, Paraguay, Uruguay). Map 1; Mexican distribution not shown.

Galactia marginalis is characterized by its procumbent stems, glabrous, 1-foliolate leaves with closely reticulate, raised venation and a completely encircling marginal vein, and large, solitary, axillary flowers.

Burkart (1971, p. 751) described *Galactia marginalis* var. *columbiana* Burkart, the type from Cundinamarca, Colombia (*H. García Barriga 10.966*, COL 000061229 digital image!), between the population systems of *G. marginalis* in Texas and southern South America. This collection and others in COL from Colombia similar to it have been identified as *G. glaucescens* Kunth by L.K. Ruiz B. in 2004 — *G. glaucescens* typically and characteristically is 3-foliolate but *G. glaucescens* var. *obtusa* (Benth.) Burkart is 1-foliolate and Ceolin and Miotto (2013) noted in the comments regarding typical *G. glaucescens* in Brazil that variation in leaflet number occurs, sometimes even on a single plant.

2. **GALACTIA ELLIOTTII** Nutt., Gen. N. Amer. Pl. 2: 117. 1818. **TYPE: USA. South Carolina**. Protologue: "Hab. In South Carolina.—S. Elliott, Esqr." South Carolina, no other data, presumably collected by *S. Elliott s.n.* (holotype: BM digital image!). The label in Nuttall's hand says "Galactia elliotii, S. Carol." A historic specimen of *G. elliotii* at PH is from Florida, collected by Baldwin.

Galactia elliottii var. *leavenworthii* Torrey & Gray, Fl. N. Amer. 1(4): 687. 1840. **TYPE: USA. Florida**. Protologue: "East Florida, Dr. Leavenworth." Not currently databased among types at NY or GH; not located at GH.

Perennial herbs, taproot slender and fusiform, producing long, white rhizomes that at intervals produce shoots as well as slender, adventitious, fusiform roots ("extremely long, narrow, subsurface root-runners, which at intervals send up a climbing shoot" (*Kral 4870*, Marion Co., Fla.). **Stems** procumbent and trailing at least proximally, often climbing-twining distally, strigose with loosely appressed hairs. **Leaflets** (5–)7(–9), blades elliptic to oblong-elliptic, oblong-lanceolate or

elliptic-oblanceolate, 17–39 x 6–21 mm, herbaceous, dark above, lighter beneath but not glaucous, sparsely strigose abaxially, veins not raised, sparsely strigose to scabrous adaxially, apices obtuse to rounded or shallowly retuse. **Inflorescence** axis 50–150 mm, flowers 3–11, on distal 1/2–1/5 of axis, sometimes fasciculate on the raceme. **Calyces** 7–9 mm, loosely strigose. **Corollas** 11–14 mm, white. **Fruits** 30–45 x 10–14 mm, loosely strigose to strigose-hirsute. **Seeds** 3–7.

Flowering May–Aug. Pine-live oak flats, slash pine flats, sand pine, marshes and marsh edges, peat bogs, ditches, roadsides, spoil areas, marl, sandy peat, white sand; 5–50 m; Fla., Ga., S.C. Map 2; some records added for this exceptionally distinct species from specimens not examined.

Galactia erecta is distinct in its pinnate leaves (leaflets 5–9) with coriaceous, dark-drying leaflets, large white flowers distally positioned on the inflorescence axis, and broad fruits.

3. **GALACTIA HETEROPHYLLA** A. Gray, Boston J. Nat. Hist. 6: 171. 1850. **TYPE: USA. Texas.** [Kimble, Llano, or Mason Co.:] On the Llano, Oct 1847, *F.J. Lindheimer Fasc. IV. 591* (holotype: GH digital image!; isotypes: GH 66215, 66216; isotypes: A, BRIT!, MICH, NY, P-3 sheets, PH-2 sheets, SI, SMU!, TEX!, US — digital images of all from all herbaria!).

Galactia grayi Vail, Bull. Torrey Bot. Club 22: 503. 1895 [nom. illeg., with *Galactia heterophylla* A. Gray cited in synonymy]. **TYPE: USA. Texas.** [Kimble, Llano, or Mason Co.:] On the Llano, Oct 1847, *F.J. Lindheimer Fasc. IV. 591* (holotype: NY; isotypes: see *G. heterophylla* A. Gray).

Vail used the name *Galactia heterophylla* (Gillies) Vail for the species now identified as *G. marginalis* Benth. (she cited *G. marginalis* in synonymy) — her intention apparently was to provide a 'correct' name for *Galactia heterophylla* A. Gray, using the same type as Gray and citing *G. heterophylla* A. Gray as a synonym, apparently under the supposition that her own *Galactia heterophylla*, based on *Cologania heterophylla* Gillies ex Hook. (1833), had priority over Gray's *G. heterophylla*. Gray, however (1840, p. 687), was aware that *Cologania heterophylla* was conspecific with *Galactia marginalis*.

Perennial herbs, arising from a very slender, elongate, woody taproot, also sometimes with rhizomes or rhizome-like caudex branches from the root apex. **Stems** procumbent, not twining, densely strigose with closely appressed, retrorse hairs. **Leaflets** 5, blades elliptic or broadly elliptic to elliptic-obovate or oblong-elliptic, 6–24 x 2–12 mm, herbaceous, glabrous adaxially or rarely sparsely strigose, margins strigose, smooth-glaucous abaxially and moderately strigose with closely appressed hairs, veins not raised, apices obtuse to rounded or shallowly retuse. **Inflorescence** axis 1–10 mm, flowers solitary and axillary or 2–5 in a reduced pseudoraceme. **Calyces** 7–9 mm, short-strigose with closely appressed hairs. **Corollas** 11–15 mm, pink, deep pink, cerise, rose-purple, lavender, purple, violet-red. **Fruits** (20–)30–45 x 5–7 mm, straight, moderately strigose with closely appressed hairs. **Seeds** 3–5.

Flowering (Mar–)Apr–Sep. Mesquite brush, blackbrush-cenizo brush, openings in live oak-thorn scrub, granite slopes, limestone ridges, roadsides, caliche outcrops, sandy prairies, hard-packed sand, sandy silt, sandy clay, gravelly sandy loam; 10–150 m; Tex.; Mexico (Coahuila, Nuevo León, Tamaulipas). Map 3; Mexican distribution not shown.

Galactia heterophylla is characterized by its procumbent, non-twining stems and particularly by its 5 leaflets with glabrous adaxial surfaces.

4. **GALACTIA STRIATA** (Jacq.) Urb., Symb. Antill. 2: 320. 1900. *Glycine striata* Jacq., Hort. Bot. Vindob. 1: 32, t. 76. 1771. **TYPE: HISPANIOLA(?).** Protologue: "Planta ... in horti caldario germinavit anno 1770 e femine ex America torrida a me allato. Regionis nomen adnotare neglexi." **LECTOTYPE** (designated here): Hort. Bot. Vindob. 1: plate 76. 1771. Figure 1.

Figure 1. Lectotype of *Glycine striata* Jacq., Hort. Bot. Vindob. 1: plate 76. 1771.

Nicolaus Joseph von Jacquin explored in the West Indies and in Venezuela and Colombia between 1755 and 1759. "Though he did prepare some dried plant specimens, it is not thought Jacquin brought back sizeable collections of these as they are rarely found in European herbaria. Joseph Banks acquired some Jacquin material, but those sheets in the Banks herbarium at BM are only scrappy and few" (BM-JSTOR 2013). JSTOR-PLANTS shows the following as possible types of *Glycine striata*: BM000589649, *Hans Sloane, s.n.*; BM000589647, *William Houston, s.n.*; LINN-HS1217-12, *Anonymous s.n.*; LINN-HL901-17, *Joseph Franz Jacquin 114*.

Burkart (1971, p. 719), following a personal communication from Dr. Velva Rudd at US, noted that the type of *Glycine striata* was at BM — it was said by Rudd to be the same specimen used to trace the original drawing. Neither the Sloane nor Houston collection (as cited above) at BM fits that description, however. Beyra M. et al. (2005, p. 489) and Ceolin and Miotto (2013, p. 12) cited a Bertero collection from Santo Domingo as the type (*Bertero 457*-BM, as "holotypus," Beyra et al.; *Bertero s.n.*-F, as "holotype," Ceolin & Miotto), but Carlo Bertero (1789-1831) did not explore in the West Indies until 1816-1821, considerably after Jacquin's publication. The lengthy and detailed description of *Glycine striata* in the Hortus Botanicus Vindobonensis protologue was said by Jacquin to be drawn from living plants grown around 1770 in the botanical garden at Vienna (where Jacquin wrote the text), and the illustration (t. 76) is best considered the lectotype and perhaps the only original material. It might be possible that the LINN specimen from Joseph Franz Jacquin (son of N.J. Jacquin) was from material grown in Vienna, but presumably there is no way of confirming this.

An epitype for *Galactia striata* will need to be provided by whoever undertakes a broader study of the complex. The Hortus Botanicus Vindobonensis illustration does not show details of vestiture, a significant feature in distinguishing among potential segregates.

Galactia cubensis Kunth, Nov. Gen. Sp. (quarto ed.) 6: 429. 1823. **TYPE: CUBA.** Protologue: "Crescit in Insulae Cubae, prope Havanam." Havana, no date, *Bonpland & Humboldt s.n.* (presumable holotype: P digital image!).

Galactia berteroana DC., Prodr. 2: 238. 1825. *Galactia striata* var. *berteroana* (DC.) Urb., Symb. Antill. 2(2): 322. 1900. **TYPE: PUERTO RICO.** Protologue: "in Porto-Ricco. (Bertero)." The original spelling of the epithet was "berteriana," corrected here to "berteroana," an adjective alluding to C.L.G. Bertero, collector of the type.

Galactia spiciformis Torrey & Gray, Fl. N. Amer. 1(2): 288. 1838. **TYPE: USA. Florida.** [Monroe Co.:] Key West, no date, *Rev. Alva Bennett s.n.* (holotype: GH 66217 digital image!; possible isotype: NY 8142 digital image!). The NY specimen, collected at Key West by "Mr. Bennett," is perhaps an isotype (it has been annotated as "Type"), but the protologue specifies the collector as "Rev. Alva Bennett," as on the GH sheet.

Perennial herbs, from an elongate woody taproot. **Stems** climbing-twining, often high-climbing, strongly lignescent, densely hirsute-pilose. **Leaflets** 3, blades elliptic to lanceolate-elliptic or ovate-elliptic, broadly elliptic, (20–)32–70 x 9–40(–50) mm, herbaceous, hirsute on both surfaces with erect to ascending hairs, veins not raised, apices rounded to obtuse or subacute. **Inflorescence** axis (70–)100–280 mm, flowers 10–20(–38) in pseudoracemes on distal 2/3–4/5 of axis, often fasciculate on the raceme. **Calyces** 5–7 mm, strigose. **Corollas** 8–11 mm, lavender, bluish, pink-purple, purple, pink, banner striped with white lines, auricled or not. **Fruits** 30–60 x 6–8 mm, straight, vestiture. **Seeds** 5–12.

Flowering all year. Hammocks, mangroves, thickets, scrubland, beaches, roadsides; 0–20 m; Fla.; West Indies, Mexico, Central America, South America. Map 4.

Galactia striata and *G. spiciformis* sometimes have both been recognized in Florida and in the West Indies, but putative distinctions observed between them have varied.

Florida (Long & Lakela 1971)
1. Leaflets ovate-lanceolate, to 6 cm long; stems and leaflets densely villous; standard strongly auriculate ..... **Galactia spiciformis**
1. Leaflets elliptic, 2–5 cm long; stems and leaflets sparingly pubescent; standard nearly truncate ..... **Galactia striata**

Bahamas (Correll & Correll 1982)
1. Leaflets typically broadly ovate-elliptic and >5 cm long, somewhat leather in texture ..... **Galactia spiciformis**
1. Leaflets typically ovate to narrowly oval and usually <5 cm long, chartaceous to membranaceous in texture ..... **Galactia striata**

Hispaniola (Liogier 1985)
1. Leaflets coriaceous or strongly chartaceous; peduncles bearing flowers from base to apex, sometimes very short ..... **Galactia spiciformis**
1. Leaflets membranous to chartaceous; peduncles without flowers on the proximal half **Galactia striata**

Cuba (Beyra M. et al. 2005)
1. Flowers in racemes, peduncles ca. 15 cm long, generally bearing flowers from base to apex; whole plant appressed-pubescent with white to bright yellow hairs ..... **Galactia spiciformis**
1. Flowers in racemes or solitary or few at axils, peduncles 3–15 long, without flowers on the proximal 1/4–1/2; the whole plant tomentose to scarcely strigose-pilose with white-opaque hairs ..... **Galactia striata**

Most Florida botanists (and including Isely 1998) have treated *Galactia striata* more broadly, including *G. spiciformis* as a synonym, and in the present study, I am not able to consistently distinguish two separate entities among the Florida plants, based on any of the criteria outlined in the key couplets above. The Cuban entity with distinctive vestiture identified as *G. spiciformis* (Beyra M. et al. 2005) apparently does not occur in Florida.

Burkart (1971) recognized three varieties within *Galactia striata*: var. *striata* and var. *tenuiflora* (Klein ex Willd.), both widespread and widely sympatric, and var. *crassirachis* Burkart, endemic to Argentina. At least seven other varieties have been recognized, as well as various synonyms at specific rank, and this variable complex needs study before evolutionary morpho-geographic patterns are clearly evident. Because *G. tenuiflora* Klein ex Willd. is treated as a distinct species in many accounts and is widely distributed, it is here considered distinct from *G. striata* in the accounting of number of species (see Appendix). Wiggins and Porter (1971) treated *G. dubia* DC. as a synonym of *G. tenuiflora* in the Galapagos flora.

5. **GALACTIA FASCICULATA** Vail, Bull. Torrey Bot. Club 22: 505. 1895. *Galactia volubilis* var. *fasciculata* (Vail) Ward & Hall, Phytologia 86: 69. 2004. **TYPE**: **USA. Florida.** [Hillsborough Co.:] Tampa, climbing on small shrubs, 24 Aug 1895, *G.V. Nash 2480* (holotype: NY 8083 digital image!; isotypes: AC digital image!, MSC digital image!, NDG digital image!, NEB digital image!, NY 8084 digital image!, OS digital image!, P-2 sheets digital images!, US digital image!). Vail noted that the type was in "Herb. Columbia College" — that specimen is NY 8083, as cited here.

Galactia floridana var. *longeracemosa* Vail, Bull. Torrey Bot. Club 22: 505. 1895. **LECTOTYPE** (designated here): **USA. Florida.** No other locality data, 1889, *J.H. Simpson s.n.* (US 4569-66799 digital image!; isotypes: MU, US-2 sheets digital images!).

Galactia volubilis var. *baltzelliana* Ward & Hall, Phytologia 86: 68. 2004. **TYPE**: **USA. Florida.** Lake Co.: 1 mi. N of Leesburg, turkey oak-longleaf pine left in vacant lots, climbing and twining over and into shrubs and trees at 1505 Moss Avenue, 25 Sep 1975, *D.W. Hall 413* (holotype: FLAS 151164 digital image!; isotypes: FLAS 151162 and 151163 digital images!)

Perennial herbs, from a woody taproot. **Stems** high-climbing, twining, strongly lignescent, loosely strigose with short, loosely appressed, retrorse hairs. **Leaflets** 3, blades elliptic, broadly elliptic or suborbicular, (12–)25–45(–64) x 10–30(–39) mm, coriaceous, adaxially glabrous and dark-colored, abaxially short-strigulose and lighter, veins not raised, apices rounded to obtuse, sometimes retuse. **Inflorescence** axis (10–)30–160 mm, flowers (3–)6–25, fasciculate in pseudoracemes along distal 1/2–3/4 of rachis. **Calyces** 6–7 mm, sparsely minutely strigose to glabrate. **Corollas** 11–14(–15) mm, lavender or purplish to pinkish. **Fruits** 30–60 x 4–6 mm, straight, densely short-strigose to strigose-sericeous with loosely appressed hairs. **Seeds** 5–9.

Flowering (Jun–)Jul–Sep. Sand-pine scrub, dunes and hills with sand pine-oak, oak-hickory, scrubby flatwoods, river banks with live oak, longleaf pine, and saw palmetto, disturbed areas; 10–30 m; Fla. Map 5.

Galactia fasciculata is distinguished by its strongly lignescent, twining and high-climbing stems with densely and loosely retrorse-strigose vestiture, coriaceous leaves dark and glossy above, and relatively short inflorescences with large flowers. It has sometimes been identified as *G. floridana* but the latter is completely distinct from *G. fasciculata* in its procumbent habit, tomentose to hirsute-villous stems, persistently hairy adaxial leaf surfaces, elongate inflorescences with distally positioned flowers, and villous calyces. There is no evidence of hybridization or intermediacy between *G. fasciculata* and *G. regularis*, as seemingly implied by Ward and Hall (2004).

6. **GALACTIA MOLLIS** Michx., Fl. Bor.-Amer. 2: 61. 1803. **TYPE**: **USA**. Protologue: "HAB. in Carolina inferiore." No label data (probable holotype: P, cat. P00798742 digital image!).
Galactia pilosa Nutt., Gen. N. Amer. Pl. 2: 116. 1818. **TYPE**: **USA. Georgia**. Protologue: "Hab. In Georgia and Carolina." Georgia, no other data, *T. Nuttall s.n.* (holotype: PH 25556 digital image!; isotype: BM 1042768 digital image!). The PH sheet has a label in Nuttall's hand as "Galactia *pilosa, Georgia." Another sheet at BM (digital image!), collected in Arkansas and identified as *Galactia pilosa* by Nuttall, is *Galactia regularis* in the sense of the present study; the BM sheet is not a type.

Elliott (1824, p. 238-239) has sometimes been credited with authorship of *Galactia pilosa*. He identified the species as "2. Pilosa ? Nutt.," providing a reference to Nuttall's publication but noting that "I feel by no means certain that this is the plant of Mr. Nuttall."

Perennial herbs, from an elongate taproot. **Stems** procumbent and trailing at least proximally, often weakly climbing-twining distally, hirsute to villous-hirsute with spreading to slightly upcurved or slightly to strongly deflexed hairs, veins not raised, apices rounded to obtuse. **Leaflets** 3, blades narrowly to broadly oblong to elliptic-oblong, elliptic, or ovate, (20–)25–50 x 10–30 mm, herbaceous, loosely strigose to pilose or villous on both surfaces. **Inflorescence** axis (3–)5–15(–20) mm, flowers 6–10 usually on distal 1/2–1/4 of axis, often fasciculate on the raceme. **Calyces** 5–8, densely villous. **Corollas** 7–10 mm, purplish-pink to red or rose-purple, drying distinctly dark reddish. **Fruits** 25–35 x 4–5 mm, straight, loosely densely strigose-sericeous to villous-sericeous. **Seeds** 7–12.

Flowering May–Jul. Longleaf pine savanna, turkey oak, pine barrens, sandhills, sandy roadsides; 20–100 m; Ala., Fla., Ga., Miss., N.C., S.C. Map 6 (records not seen from NC and SC added from Wilbur 1968; abundant records of *Galactia mollis* in Mississippi and Alabama databases based on misidentifications).

7. **GALACTIA MINOR** Duncan, Phytologia 37: 59. 1977. **TYPE**: **USA. Georgia**. Long Co.: Sandhills adjacent to Altamaha River bottom SW of Ludowici, 2 Aug 1953, *W.H. Duncan 16993* (holotype: GA; isotype: VDB!).

Perennial herbs, arising from an elongate, cylindric, woody taproot. **Stems** procumbent, trailing, not twining, densely short-strigulose with minute, antrorsely closely appressed hairs; internodes about as long as longest leaflet of the adjacent nodes. **Leaflets** 3, blades elliptic, oblanceolate-elliptic, oblong-elliptic, (7–)9–25(–30) x (4–)7–10(–18) mm, subcoriaceous, glabrous adaxially, sparsely strigose abaxially and lighter colored but not glaucous, veins raised on both surfaces, apices rounded to slightly retuse, rarely acute. **Inflorescence** axis (5–)10–20(–35) mm, flowers solitary and axillary or 2–4 in a reduced pseudoraceme. **Calyces** 7–10 mm, strigose. **Corollas** 11–17 mm, pink. **Fruits** 25–45 x 4–5 mm, straight, strigose. **Seeds** 3–8.

Flowering Jun–Aug(–Oct). Sandhills and sandy ridges, roadsides, pine flats, pine-scrub oak, turkey oak, longleaf pine; 0–100 m; Ala., Fla., Ga., Miss., N.C., S.C. Map 7.

Galactia minor is a distinct species with procumbent, antrorsely strigulose stems, small, congested leaves with glabrous adaxial surfaces and raised venation, few flowers on a short inflorescence axis, and relatively large corollas.

8. **GALACTIA BRACHYPODA** Torr. & Gray, Fl. N. Amer. 1(2): 288. 1838. **TYPE**: **USA. Florida**. Protologue: "Dry pine barrens, Middle Florida, Dr. Chapman!" Dry barrens, no date, *A.W. Chapman s.n.* (holotype: NY 8088 digital image!, Figure 2; probable isotype: NY 8090 digital image). Another Chapman collection at NY has been tentatively identified as *G. brachypoda* (8089) — but it is *G. erecta*, which perhaps accounts for the placement of *G. brachypoda* in some accounts as a synonym of *G. erecta* (e.g., Vail described and keyed *G brachypoda* as having an erect habit). It also presumably accounts for why Isely (1998, p. 566) thought the type was so aberrant ("probably either a freak form of *G. erecta* or an exceptionally rare hybrid with one of the viny species") — if not, the basis of his statement is not clear.

Galactia purshii Desv., Ann. Sci. Nat. (Paris) 9: 413. 1826 [nom. illeg.]. Desvaux observed that "*Galactia glabella* DECAND., Prod., 2, p. 238, excl. syn." was a "confused species" and apparently somehow hoped to reduce the confusion by providing the new name, noting only that "La phrase diagnostique de l'auteur du Prodrome est suffisante." DeCandolle (Prodr. 2: 238. 1825), however, clearly attributed the name to Michaux and the Prodromus description fits Michaux's concept as well as the associated type specimen.

Galactia mollis Michx. var. *nashii* Vail ex Small, Fl. S.E. U.S., 720. 1933. **TYPE**: **USA. Florida**. Lake Co.: Vicinity of Eustis, high pine land, Jul 1894, *G.V. Nash 880* (holotype: NY 8093 digital image!). Following the description of *G. mollis*, Small (p. 720) noted that "G. mollis Nashii Vail has stem only lightly pubescent." The name was not included in Vail's treatment, but the NY specimen was annotated in pencil by "A.M.V." (Anna Marie Vail) as "G. mollis Nashii n. var.?"

Perennial herbs, from an elongate, narrowly fusiform to cylindric, woody taproot. **Stems** procumbent, creeping, not rooting at nodes, sometimes weakly twining distally, minutely strigose with retrorsely appressed hairs or with antrorsely appressed hairs. **Leaflets** 3, elliptic to elliptic-lanceolate or broadly lanceolate to oblong-elliptic, sometimes linear-elliptic in se N.C. to ne Ga., (8–)15–45(–60) x (4–)10–25(–32) mm, subcoriaceous, adaxially glabrous to sparsely short-strigose or minutely hirtellous and darker, slightly glossy or not, abaxially moderately to densely short-strigose with closely appressed hairs, lighter green but not glaucous, veins slightly but distinctly raised adaxially or on both surfaces, apices obtuse to rounded or shallowly retuse. **Inflorescence** axis (5–)20–80(–150) mm; flowers (3–)5–15(–25), rarely 1–2, in pseudoracemes on distal 3/4 of shorter axes or usually on distal 1/4–1/5 of longer axes, often fasciculate on the raceme distally. **Calyces** 5–7 mm, sparsely strigose to glabrate. **Corollas** 11–15 mm, lavender or violet to purplish, bright pink, or pinkish.

Figure 2. Holotype of *Galactia brachypoda* Torrey & Gray. The habit is procumbent and essentially non-twining. Leaflets vary in shape from relatively narrow (as in the holotype) to more broadly elliptic.

Fruits (25–)30–60 x 4–5(–6) mm, straight, densely strigose to strigose-sericeous, glabrescent. **Seeds** (3–)5–8(–12).

Flowering (Mar–)Apr–Sep. Sand pine-slash pine, white sand scrub, oak and pine-oak scrub, turkey oak woodland, longleaf pine savanna, pine flatwoods, oak-hickory woods, pine-oak margin, xeric hammocks, low dunes, sandhills and ridges, sandy fields, roadsides, swamp margins, ditches, canal and river banks, river terraces, vacant lots and other disturbed sites; 5–100 m; Ala., D.C., Fla., Ga., Md., N.J., N.C., S.C., Va. Map 8.

Plants of *Galactia brachypoda* are characterized by their essentially procumbent habit with mostly non-twining stems (sometimes weakly twining distally), minutely strigose (antrorse or retrorse) cauline vestiture, subcoriaceous leaflets with raised venation, and relatively large corollas. Plants of *G. brachypoda* with distally twining stems and relatively small leaves might be mistaken for *G. regularis* (which see for comments regarding type-based confusion between the two species), but the latter has climbing and consistently twining stems with looser and non-appressed vestiture, thinner leaves, and longer inflorescences with curved axes and smaller, less congested flowers.

Duncan (1979, p. 174) mapped three morpho-geographic entities of *Galactia brachypoda* (but identifying the species as *G. glabella*) emphasizing stem vestiture — the widespread form has appressed-retrorse hairs, while the other two have appressed-antrorse hairs.

The "retrorse" population system occurs from Florida northward into southeastern Virginia, with an apparent disjunction in Maryland (as mapped by Duncan). The two "antrorse" systems are allopatric:

(a) "Antrorse" plants from Florida and southeastern Georgia are represented by the type of *G. brachypoda*. A collection of antrorse plants has been made from considerably west of the main system: (Alabama. Mobile Co.: Spring Hill, 3 Aug 1897, *Bush 80*, MO, 2 sheets). In Florida, retrorse and antrorse populations are allopatric for the most part, with typical *G. brachypoda* mostly in the western half of the peninsula and distinct in its more mesic, often disturbed habitats (mesic pine flatwoods, oak and pine-oak scrub, sandy fields, swamp margins, ditches, canal banks, river terraces, vacant lots (the type collection of *G. brachypoda*, however, was made from "dry barrens"). In Florida, retrorse populations characteristically occur in sand pine-slash pine, white sand scrub, pine flatwoods, xeric hammocks, roadsides, low dunes, and sandhills.

(b) A northern, primarily "antrorse" system occurs in southeastern North Carolina, South Carolina, and Georgia — these plants characteristically have relatively narrow leaflets and should be studied toward possible formal taxonomic recognition. Stem vestiture in the narrow-leaflet populations includes retrorse forms, perhaps a reflection of gene flow with sympatric populations of different vestiture.

Several collections of broad-leaflet "antrorse" plants have been made near the northern extremity of the retrorse population system (e.g., Anne Arundel Co., Md., *Plitt 67* (MO); Alexandria Co., Va., *Newbold 689* (MO).

Duncan noted (p. 176) that "I have no strong feelings as to how the 'antrorse' population[s] should be treated, as a separate species, as a variety of *G. minor* or *G. glabella*, or otherwise. ... Until further studies can be made, it seems best to include these as forms of *G. glabella*, providing them with no names." Duncan's observations regarding orientation of stem vestiture are essentially confirmed in the present study and like Duncan, I am not able to find any other difference that would consistently distinguish among these population systems and thus here identify all three collectively as *G. brachypoda*. Analogous, alternate orientation of cauline vestiture occurs in *G. joselyniae*, *G. smallii*, *G. microphylla*, and *G. pinetorum*, where there is strong certainty that only a single species is

involved. Still, it seems that a better understanding of how the variation is partitioned in *G. brachypoda* might be possible with field observations and more detailed study.

9. **GALACTIA FLORIDANA** Torrey & Gray, Fl. N. Amer. 1(2): 288. 1838. **TYPE: USA. Florida.** [Hillsborough Co.:] Tampa Bay, no other collection data (probable holotype: NY digital image!). The protologue: "Sandy places about Tampa Bay, Florida, *Dr. Burrows*!" A sheet at GH ("ex herb. J. Torrey") is the same species but has slightly different leaf morphology, surely from a different plant, and is unlikely to be a duplicate of the NY sheet -- the GH label has handwritten by A. Gray "Galactia Floridana Chapm. n. sp., Florida."

Galactia brevipes Small, Fl. S.E. U.S., 649, 1332. 1903. **TYPE: USA. Georgia.** Charlton Co.: St. Mary's River swamp, below Trader's Hill, 24-26 Jul 1895, *J.K. Small s.n.* (holotype: NY digital image!).

Perennial herbs, from an elongate, narrowly fusiform, woody taproot. **Stems** procumbent, creeping, rooting at nodes, sometimes climbing-sprawling but not twining, up to 4 feet, densely short-tomentose to hirsute-villous with spreading-erect, irregularly oriented hairs. **Leaflets** 3, elliptic to broadly elliptic, thickened-coriaceous, much darker adaxially, (14–)20–55 x (10–)15–35 mm, herbaceous, sparsely persistently strigose-sericeous adaxially with loosely appressed hairs, veins not raised, apices rounded to truncate, commonly shallowly retuse. **Inflorescence** axis 20–100(–130) mm, flowers 5–12(–25) in a pseudoraceme on distal 1/2–1/4 of axis, fasciculate on the raceme. **Calyces** 7–8 mm, villous. **Corollas** 12–15 mm, pink to purple or rose-purple. **Fruits** 30–45 x 3–4(–5) mm, straight, densely villous-hiirsute. **Seeds** 7–11.

Flowering Mar–Aug(–Sep). Open pine woods, pine barrens, longleaf pine-turkey oak-blue oak woods, sandhill scrub, sandhills, roadsides; 10–30 m; Ala., Fla., Ga., La., Miss. Map 9.

Small (1903, 1913, 1933) distinguished *Galactia brevipes* from *G. floridana* by its panicles longer than the leaves and its separated flower clusters (vs. panicles shorter than the leaves or slightly longer and flower clusters approximate). Intermediate forms are common. The species is recognized by its procumbent, densely short-tomentose to hirsute-villous stems, relatively large, thick leaves (compare *G. microphylla*), and large flowers.

Westernmost known localities for *Galactia floridana* are disjunct from the main range, perhaps displaced by storms: **Alabama**. Mobile Co.: Spring Hill, common in woods, 3 Aug 1897, *Bush 304* (MO), 6 Aug 1897, *Bush 302* (MO); Spring Hill, open woods, May 1918, *Graves 1092* (MO); Mobile, Univ. of S. Alabama, open woodlands, 11 Oct 1969, *Rogers 1886* (MO). **Louisiana**. Cameron Par.: Holleyman Bird Sanctuary and I-10 near Sulphur, 5-6 Apr 1986, *McKenzie 264* (LSU digital image!). **Mississippi**. Jackson Co.: Petit Bois Island, stable sand near the coast, 7 Aug 1952 ["8-7-1952"], *Demaree 32599* (ASU).

10. **GALACTIA SMALLII** Rogers ex Herndon, Rhodora 83: 471. 1981 [nom. nov., replacing *G. prostrata* Small]. *Galactia prostrata* Small, Man. S.E. Fl., 719, 1505. 1933 (not *Galactia prostrata* Benth. 1837). **LECTOTYPE** (designated here): **USA. Florida.** Dade Co.: Pinelands, Redland district, 13 May 1918, *J.K. Small 8633* (NY digital image!).

Small cited two types (syntypes) — one for flowers (*Small 8633*, NY) and one for fruits (*Small, Mosier, & Small 6453*, NY). This was repeated by Herndon (1981) in providing the replacement name for the original *G. prostrata* Small. *Small 8633* has both flowers and fruits.

Perennial herbs, from a thick-fusiform, woody taproot. **Stems** procumbent, distally twining, densely to sparsely hirsute-villous to hirsute with slightly deflexed hairs, loosely retrorsely hirsute-villous, or antrorsely hirsute-villous with spreading-ascending hairs. **Leaflets** 3, blades broadly elliptic to broadly elliptic-oblong or suborbicular, 8–25 x 6–20 mm, herbaceous, both sides villous-hirsute with ascending hairs or upper minutely hirsute, veins not raised, apices rounded or usually

shallowly retuse. **Inflorescence** axis (5–)20–60(–90) mm, flowers solitary and axillary or 2–6 in a reduced pseudoraceme at distal 1/4–1/8 of axis. **Calyces** 6–7 mm, strigose to hirsute. **Corollas** 10–15 mm, lavender-pink to purple. **Fruits** 25–50 x 5 mm, straight, densely strigose, surface at least sometime white-glaucous. **Seeds** 7–11.

Flowering Mar–Oct or sporadically all year, abundantly after burns. Pine rockland-slash pine with a shrub canopy of saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), poisonwood (*Metopium toxiferum*), and willow Bustic (*Sideroxylon salicifolium*) over outcropping oolitic limestone; 0–5 m; Fla. (Dade Co.). Map 10.

Specimens examined. **Florida**. Dade Co.: Eureka Drive, just W of Old Cutler Road, burned pineland, prostrate on rock, tardily twining on grasses, 6 Oct 1979, *Avery 2164* (USF); bulldozed pineland at SE corner of Old Cutler Road and US 1, prostrate except for some tips twining, 4 May 1980, *Avery 2229* (NCU, USF); ca. 1 mi W of Homestead, jct SW 192 Ave, SW 344 St., frequent in cleared pineland, 18 Apr 1964, *Burch and Godfrey 312* (TEX); Gossman's, field in pine woods, 25 Feb 1905, *Eaton 1249* (LL); W side of road to Everglades Natl. Park, 0.5 mi S of W. Palm Drive, near Florida City, prostrate, trailing vine at edge of woods, thin soil over limestone, 14 Mar 1982, *Hill 10912* (MO); near US 1 in Homestead, in coral sand and rock, 23 Apr 1949, *Janish 635* (MO); Old Cutler Road, vicinity of Fairchild Tropical Farden, low outcroppings of oolite, pineland with *Serenoa* and *Thrinax*, 1 Jul 1965, *Lakela 28766* (USF); pinelands about Ross Hammock, 23 Jun 1915, *Small, Mosier, and Small 6526* (MO); Seminole Wayside Park, E side of US 1, just S of 296th St., in open areas of pine rockland, 20 Mar 1998, *Woodmansee 30* (USF).

Galactia smallii is endemic to rocky habitats in Dade County and is recognized by its procumbent habit with stems distally twining, stems and leaves variably spreading-hairy to loosely strigose (antrorse or retrorse), and relatively large flowers. The lectotype (*Small 8633*, NY) has spreading cauline vestiture (though strongly glabrescent and not evident on portions of the stems); a photo and line drawing by FNAI (2000) show spreading vestiture. Other collections from the Dade County rocklands essentially identical otherwise in morphology have either spreading hairs or retrorsely or antrorsely oriented hairs, and it appears that all of these plants should be considered as a single population system with variable vestiture. Other species apparently with variable orientation of cauline vestiture are *G. brachypoda*, *G. joselyniae*, and *G. pinetorum*.

The procumbent-sprawling, non-twining habit of *Galactia smallii* and its broadly elliptic to elliptic-oblong leaves are similar to both *G. brachypoda* and *G. floridana*. It is essentially sympatric with *G. brachypoda* at the southernmost extremity of its range but disjunct (a short distance) from *G. floridana*. The cauline vestiture of *G. floridana* is consistently spreading, while that of *G. brachypoda* is tightly appressed, either antrorsely or retrorsely; thus the variable vestiture in *G. smallii* might be considered an amalgum from both of these putative close relatives. *Galactia smallii* differs from *G. floridana* mostly in its stems not rooting at the nodes, smaller leaflets, and fewer flowers.

11. **GALACTIA MICROPHYLLA** (Chapm.) Hall & Ward ex Isely, Brittonia 38: 354. 1986. *Galactia floridana* Torrey & Gray var. *microphylla* Chapm., Fl. South. U.S., 108. 1860. **TYPE: USA. Florida**. No other data, *A.W. Chapman s.n.* (probable holotype: NY 00008130 digital image!).

Galactia mollis var. *microphylla* A. Wood, Amer. Bot. Fl., 98. 1870. Protologue: "Lfts. small (4-6"), oval; fls. solitary, and nearly sessile in the upper axils; pods 5 or 6-seeded. Ga. Fla. (Miss S. Keen.)." **TYPE** not seen; not currently databased among types at NY or GH. The name is only provisionally placed here.

Perennial herbs, from an elongate, often napiform taproot. **Stems** procumbent, not twining, herbaceous to lignescent, hirsute-villous with irregularly to strongly deflexed hairs, rarely nearly appressed-retrorse. **Leaflets** 3, blades elliptic, 10–30 x 5–16 mm, herbaceous, strigose to glabrescent or glabrate adaxially, glossy, glaucous and sparsely short-strigose abaxially with appressed to ascending hairs, veins not raised, apices rounded to obtuse. **Inflorescence** axis 10–20 mm, flowers solitary and axillary or 2–6 in a reduced pseudoraceme. **Calyces** 3–4 mm, closely strigulose. **Corollas** 6–7 mm, light purple. **Fruits** 25–45 x 4–5 mm, straight, short-hirsute with spreading hairs. **Seeds** 3–8.

Flowering Apr–Sep(–Oct). Longleaf pine woodland, scrub, dunes, sandy hills and slopes; 0–10 m; Ala., Fla. Map 4.

Collections examined. **USA. Alabama**. Baldwin Co.: Fort Morgan Peninsula, P.O. Gulf Shores, stable areas, 1 Aug 1954, *Demaree 35909* (USF). Butler Co.: Burnt and bulldozed sands of longleaf pine hills by I-65, S of Georgiana turnoff, 14 Oct 1978, *Kral 63031* (VDB). Covington Co.: Ca. 14 mi S of Opp, sandy longleaf pineland, 5 Oct 1968, *Kral 33666* (VDB); sandy cleared slope above Pigeon River where crossed by Ala 55, SE of McKenzie, 30 Aug 1970, *Kral 40855* (VDB). **Florida**. [Escambia/Santa Rosa/Okaloosa Co.:] Santa Rosa Island, 4 Aug 1941, *Brinker 389* (MO); Santa Rosa Island, 30 Aug 1899, *Tracy 6333* (MO). Escambia Co.: Santa Rosa Island, 2 mi E of Pensacola Beach in dunes along S. Rd. 399, 10 Sep 1977, *Carlton s.n.* (USF). Santa Rosa Co.: 1 mi E of Pensacola Beach on S-399, sand dunes, 9 Sep 1977, *Crewz 1136* (USF). Walton Co.: 5 mi W of Santa Rosa, in deep, white, dune sand, 4 Sep 1954, *Turner and Tharp 3674* (TEX).

Compared to *Galactia floridana*, *G. microphylla* has shorter internodes, smaller and thinner leaves light green on both surfaces and glaucous beneath, shorter inflorescences with fewer flowers, and minutely and closely strigulose calyces.

12. **GALACTIA LONGIFOLIA** (Jacq.) Benth., Ann. Wiener Mus. Naturgesch. 2: 127. 1838. *Galega longifolia* Jacq., Collectanea 2: 349. 1788. *Sweetia longifolia* (Jacq.) DC., Prodr. 2: 381. 1825. *Tephrosia longifolia* (Jacq.) Pers., Syn. Pl. 2(2): 328. 1807. **TYPE: USA**. Not located (W?). Color illustration in Jacq., Icon. Pl. Rarior. 3: 14, t. 572. 1793.

As a synonym of *Galactia longifolia* (Jacq.) Benth., Urban (Symb. Antill. 2: 313. 1900) cited "*Galactia angustifolia Griseb.! Kar. (1857) p. 56* [Syst. Unters. Veg. Kar., 56. 1857] *et Flor. p. 194* [Fl. Brit. W.I., 194. 1864]; *Duss! Flor. Ant. franc. p. 210, — non Kth.*" *Galactia angustifolia* Griseb. has sometimes been listed as a valid name but Grisebach's accounts in 1857 and 1864 both clearly attributed the name to Kunth, thus Urban surely intended the 1900 listing to be interpreted as "in the sense of Grisebach's usage."

Perennial herbs, basal parts not seen. **Stems** climbing-twining, moderately minutely strigose with loosely appressed, retrorse hairs. **Leaflets** 3, blades narrowly oblong to oblong-lanceolate, 25–75 x 6–14 mm, herbaceous, moderately to densely minutely strigulose on both surfaces with closely appressed hairs, veins not raised, apices rounded to obtuse. **Inflorescence** axis 30–120(–280) mm, flowers solitary and axillary or 2–8(–16) in a pseudoraceme on distal 1/4 of axis, sometimes fasciculate on the raceme. **Calyces** 5–6 mm, strigulose. **Corollas** 10–11 mm, lavender. **Fruits** 35–65 x 4–6 mm, straight, sparsely minutely strigulose with closely appressed hairs. **Seeds** 12–15.

Flowering Apr–Aug(–Sep). Coastal prairie, clay, poorly drained sandy loam; 10–30 m; Tex.; South America (fide Burkart 1971: Argentina, French Guiana, Paraguay), West Indies (Hispaniola, Puerto Rico, Lesser Antilles [fide Wiersema et al. 1990: Barbados, Grenada, Guadeloupe, Martinique, St. Christopher, St. Lucia, St. Vincent]). Map 16.

In Texas, as identified here, *Galactia longifolia* is known from a cluster of five coastal counties (Aransas, Brazoria, Calhoun, Jackson, Victoria). The irregularly scattered distribution of this species (southern South America, French Guiana, Caribbean, Texas, Florida) suggests that it is not monophyletic.

13. **GALACTIA REGULARIS** (L.) Britton, Sterns, & Poggenb., Prelim. Cat. New York, 14. 1888. *Dolichos regularis* L., Sp. Pl. 2: 726. 1753. **LECTOTYPE** (Duncan 1979, p. 173, fide Jarvis 2007): **USA. Virginia**. Protologue: "Habitat in Virginia." *J. Clayton 121* (BM 38167 digital image!, Figure 3). Duncan's discussion in 1979 clearly was in reference to the morphology of *Clayton 121* but he identified the specimen only as "Virginia — Clayton — ex Herb. Gronovii in BM," without a specific indication of which Clayton collection; *Clayton 213* (BM) is the species identified here as *Galactia brachypoda*.

In any case, the specimen associated by Linnaeus with his *Galactia regularis* is unequivocally clear. He cited "8. DOLICHOS foliis ovatis obtusis, pedunculis multifloris, petalis aequalis magnitudinis figuraeque, Gron. [as 'Gorn.'] virg. 82. Habitat in Virginia." The species identified by this phrase in Gronovius (ed. 1, p. 82-83) explicitly cites *Clayton 121* at the end of the description; the immediately preceding species (p. 82) cites *Clayton 213*. *Clayton 213* is the procumbent-stemmed, large-flowered species identified here as *G. brachypoda*. *Galactia regularis* and *G. volubilis* refer to the same species (recognized here as *G. regularis*, in agreement with Duncan 1979).

Ervum volubile Walt., Fl. Carol., 187. 1788. **TYPE: USA.** Not specified; apparently not included among names dealt with in the Thomas Walter Typification Project by Ward in 2006-2008. Protologue: "caule volubili, pedunculis multifloris, floribus geminatis incarnatis vexillo subtus glauco, foliis ternatis ovatis utrinque emarginatis." Placement of this name as a synonym by various authors apparently has been only speculative, since the protologue does not give enough information for an unambiguous identification. With twining stems and ovate, emarginate leaflets and the probable South Carolina locality, and with the certainty that it is not *Ervum erectum* (= *Galactia erecta*), the only other species of *Ervum* included by Walter, it seems possible that he was referring to *Hedysarum volubile* of Linnaeus, perhaps intending his name as a new combination in *Ervum*. De Candolle (Prodr. 2: 238. 1825) included *Ervum volubile* Walt. as a synonym of *G. glabella* Michx. but presumably based solely on Walter's description.

Galactia villosa Nutt. ex Eaton & Wright, Man. Bot. (ed. 8) 248. 1840 [nom. illeg., not *G. villosa* Wight & Arn. 1834]. Eaton and Wright listed this name as "villosa, N" — the "N" obviously signifying Nuttall as it did also in *G. elliottii* and *G. pilosa* of their account. For *G. villosa*, they cited neither geographic range nor collection data and the minimal description hardly eliminates any species.

Galactia volubilis (L.) Britt. var. *mississippiensis* Vail, Bull. Torrey Bot. Club 22: 508. 1895. *Galactia mississippiensis* (Vail) Rydb., Fl. Plains N. Amer. 493. 1932. **TYPE: USA.** Protologue: "Missouri, Arkansas, Indian Territory, and Louisiana. An oval, pilose-leaved form that in Missouri seems very distinct, but specimens from other localities seem to intergrade with the broader leaved form of the type." No type cited, not located (NY?).

Perennial herbs, from an elongate woody taproot. **Stems** climbing-twining, herbaceous, moderately to densely hirsute to hirsute-villous with spreading-deflexed hairs. **Leaflets** 3, blades elliptic to broadly elliptic, oblong-elliptic, or lanceolate-elliptic, (10–)14–40(–50) x (5–)10–21(–25) mm, herbaceous, sparsely strigose abaxially and often glaucous, minutely and sparsely short-strigose adaxially, veins not raised, apices obtuse to rounded or shallowly retuse. **Inflorescence** axis 10–70(–150) mm, flowers solitary and axillary or 2–7(–9) in a reduced pseudoraceme on the distal 1/2–3/4 of the axis, often fasciculate on the raceme. **Calyces** 4–6 mm, hirsute-villous. **Corollas** 7–10 mm, pink to rose, light violet, pink-purple, rose-purple. **Fruits** 20–50 x 3–5 mm, straight, vestiture. **Seeds** 5–9.

Flowering (Jun–)Jul–Aug. Oak and pine-oak woods, woodland borders, fence rows, low fields, pond and stream margins, ditches, roadbanks, open disturbed sites; 20–500(–900) m; Ala., Ark., Del., Fla., Ga., Ill., Ind., Kan., Ky., La., Md., Miss., Mo., N.J., N.Y., N.C., Ohio, Okl., Penn., S.C., Tenn., Tex., Va., W.Va. Map 11.

Several collections of *Galactia regularis* have been made in Texas at localities long-disjunct from the main range. **Texas**. Brewster Co.: Glass Mts, scattered on Iron Mt., 20 Aug 1940, Warnock W76 (SMU, TEX). Cameron Co.: 1/2 mi SW of Olmito, 2 Dec 1945, *Cory 51457* (SMU); occasional near the coast and at Rabb Palm Grove and Brownsville, 28 Jul 1965, *Runyon 5909* (SRSC).

Application of the names *Galactia volubilis*, *G. regularis*, *G. macreei*, and *G. glabella* has been controversial and inconsistent but typifications outlined in the present study strongly constrain the taxonomy. Duncan's assessment (1979) of the two twining species was mostly correct. *Galactia regularis* refers to the species widespread in the eastern USA, with leaflets mostly elliptic to broadly elliptic, relatively small flowers, and twining stems hirsute-villous with deflexed hairs. *Galactia volubilis* (with *G. glabella* and *G. macreei* as synonyms) is the species with characteristically narrowly oblong leaflets, slightly larger flowers, and twining, sparsely antrorsely strigose to glabrate stems (see Figs. 7a, b, and c for leaflet variability in *G. regularis* and *G. volubilis*) — it is distributed mostly on the coastal plain from North Carolina to Georgia and Floirda, then westward to Arkansas, Louisiana, and Texas. *Galactia brachypoda* (= *G. glabella* sensu Duncan 1979) is the species with relatively larger flowers and procumbent, short-strigose stems — it is a coastal plain species from Maryland and Virginia to Alabama.

Usage of the names

Since the two Linnaean names were brought into use in *Galactia* (*G. regularis* in 1888, *G. volubilis* 1894), use of *G. volubilis* has been used in most instances to identify the species of twining plants with small flowers and deflexed-hirsute-villous stems. In making the combination for *G. regularis*, Britton et al. placed *G. glabella* (apparently in the sense of *G. brachypoda* here) in its synonymy; six years later he brought in *G. volubilis* (in the sense of *G. regularis* here).

Confusion between *Galactia glabella* and *G. regularis* began at least as early as 1825, when de Candolle (Prodr. 2: 238) placed *Dolichos regularis* L. 1753 as a synonym of *G. glabella* Michx. 1803, noting that two species were perhaps confused in circumscription. Torrey and Gray (1838) did not include *D. regularis* or *Hedysarum volubilis* even as syonoyms, but *G. regularis* has included *G. glabella* as a synonym in continuing general usage (e.g., Britton et al. 1888; Britton & Brown 1897; Mohr 1901, Small 1903, 1913, 1933; Fernald 1950; Gleason & Cronquist 1991; Isely 1998).

Duncan (1979) recognized that the types of *Galactia regularis* and *G. glabella* were different species. *Galactia regularis* is the name of the species identified for nearly 100 years as *G. volubilis*, while *G. glabella* refers to the narrower-leaflet, larger-flowered, twining plants but is a synonym of *G. volubilis*. Usage of the name *G. volubilis* took a sudden turn when Duncan (as followed here) concluded that it applied to the narrower-leaflet species (here including *G. macreei* and *G. glabella*).

Galactia macreei commonly has been treated as a synonym of either *G. volubilis* or *G. regularis* (Vail 1895; Duncan 1979; Isely 1998; Wunderlin & Hansen 2011; Ward & Hall 2004; Weakley 2012; Weakley et al. 2012). Remarkably, Small (1933) did not include it even as a synonym. For Texas, Turner (1959, 1971) and Turner et al. (2003) recognized *G. macreei* but his concept apparently included scattered variants of *G. volubilis*. Duncan (1979) treated *G. macreei* as a distinct species (synonymous with *G. volubilis*). The narrower-leaflet species is recognized here (as *G. volubilis*) as distinct, in agreement with Fernald (1950), Wilbur (1963, 1968), Long and Lakela (1971), and Gleason and Cronquist (1991).

THE NATURAL HISTORY MUSEUM, LONDON
DEPARTMENT OF BOTANY
000038167 (BM)
Photographed March 1937
Photographed September 1947
Linnaean Typification Project
Dolichos regularis L.,
Sp. Pl. 2: 726. 1753.
Clayton 121
Lectotype!
= Galactia regularis (L.) Britton, Sterns & Poggenb.,
Prel. Cat. New Yol. Ank. 14. 1888.
James L. Reveal 1989
University of Maryland, College Park, MD 20742 — MARY
BRITISH MUSEUM (NATURAL HISTORY)
HERBARIUM MUSEI BRITANNICI
Virginia-Clayton
Ex. Herb Gronovii
A.S.Bot.741
Phaseolus foliis glabris cordi, exquinis ahs flores purpurascentes pedunculo longissimo tenui spicatim exeuntes, L. replies. Clayt.
A trifoliated slender twining plant with small reddish flowers, growing in spikes from the joings of the leaves. L. Clayton ex Virginia num. 121
Dolichos foliolis ovatis obtusis pedunculis multiflors racemosis petalis cordatis aequalis negrisdimidio longioribus.
Flor. Virg. pub. 3. p. 81. Linn. Syst. gen. 1760. n. 8.
D. lobatus regularis.

Figure 3. Lectotype of *Dolichos regularis* L.

Figure 4. Lectotype (Reveal & Jarvis 2009) of *Hedysarum volubile* L. Plate 143, in Dillenius, Hort. Eltham. 1: 173, t. 143, fig. 170. 1732. Leaflet shape of the illustrated plants is unequivocally that of *Galactia volubilis* as treated here (see Figs. 7a, b, c), but the stem vestiture is more like that of *G. regularis*.

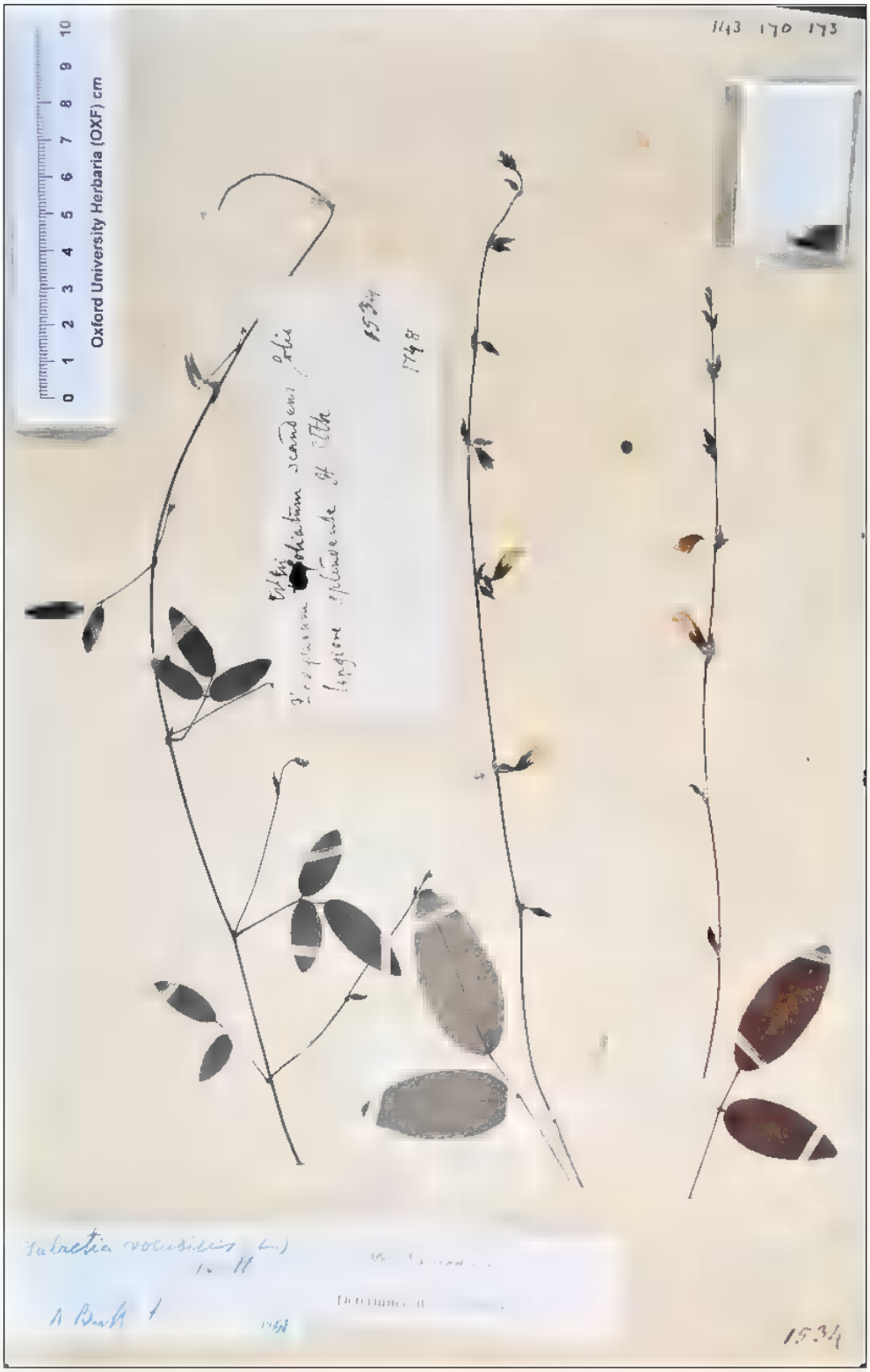

Figure 5. The OXF specimen putatively associated with the Dillenius illustration (from color images sent by OXF Curator Stephen Harris). Clearly identified as to *G. volubilis* in the sense here.

14. **GALACTIA VOLUBILIS** (L.) Britt., Mem. Torrey Bot. Club 5: 208. 1894. *Hedysarum volubile* L., Sp. Pl. 2: 750. 1753. **LECTOTYPE** (Reveal & Jarvis 2009): **USA.** [Virginia? or more likely further south, where the species is more common): No other data. Plate 143 of Dillenius, Hort. Eltham. 1: 173, t. 143, fig. 170. 1732. Here as Figure 4.

As noted by Jarvis (2007): "Torrey and Gray stated [1840, p. 365] that the name was 'founded upon' Dillenius [Hort. Eltham., plate 143, 1732], but this is not accepted as equivalent to the use of 'type'" (thus did not effect a lectotypification).

Protologue: "26. HEDYSARUM foliis ternatis ovato-oblongis, caule volubili. *Hort. cliff.* 499. *Roy. lugdb.* 385. Hedysarum trifolium scandens, folio longiore splendente. *Dill. elth.* 173, t. 143. f. 170. Habitat in America septentrionalis."

The Hortus Cliffortianus entry: "6. HEDYSARUM foliis ternatis, ovato-oblongis, caule volubili. Hedysarum trifolium scandens, folio longiore splendente. *Dill. elth.* 173, t. 143. f. 170. Crescit in America septentrionali."

The original and complete description, including reference to the Dillenius plate, was published in Hortus Cliffortianus of 1737 (above). Van Royen's Florae Leydensis of 1740 ("Roy. lugdb.") repeated the Hortus Cliffortianus entry and cited it. The Species Plantarum entry of 1753 again repeated the description and cited both earlier publications.

Duncan (1979) observed that a specimen in the Dillenius herbarium (OXF) is part of the original material of *Hedysarum volubile* (putatively associated with the Hortus Elthamensis illustration). Duncan concluded that the illustration is ambiguously identified but that the OXF specimen is the same species as typified by *Galactia macreei*. The original label of the OXF specimen (Figure 5; "1534," without collector or locality; from observations and color images sent to me by OXF Curator Stephen Harris) has the original phrase associated with *Hedysarum volubile* but it is dated "1748," postdating the publication of Hortus Elthamensis — thus the specimen apparently did not underlie the illustration and the lectotypification is correctly based only on the illustration.

In the interpretation here, however, the Dillenius illustration and OXF specimen represent the same species. The identity of the specimen is unequivocal — it has stems with closely retrorsely appressed stem vestiture of short hairs (fide Stephen Harris), narrowly elliptic-lanceolate leaflets with glaucous lower surfaces, long inflorescences, and relatively large flowers. The illustration shows a plant with twining stems, leaflets of characteristic shape (like the illustration), and larger flowers; stem vestiture is portrayed as more similar to *G. regularis* — this might reflect genetic influence from *G. regularis* or it could have been simply a slight exaggeration by the artist to show the orientation of the hairs.

Galactia glabella Michx., Fl. Bor. Amer. 2: 62. 1803. **TYPE: USA. South Carolina.** Colleton Co.: Protologue: "Hab. in Carolina and Georgia." Label: "Col. Co. S. Carolina" (holotype: P-Michaux, microfiche image!, Figure 6). Duncan (1979, p. 175) noted that in Michaux's time, Colleton County included all of Charleston County southwest of the Ashley River.

The filiform, tightly twining stems, the narrowly oblong-ovate leaflets, the description by Michaux of the glabrous calyx ("calycibus glabris") and the plant as generally glabrous ("GLABELLA. G. glabriuscula"), and the geographic location provide barely controvertible evidence for associating the Michaux type with the species generally identified as *Galactia macreei*. Duncan used the name *G. glabella* for the procumbent species (identified here as *G. brachypoda*), explicitly choosing to regard the twining feature clearly evident in the type as a "possible discrepancy."

A fragmentary specimen in the general collection at P (cat. P00798727 digital image!, labeled as "Isotype") is not the same species as that in the Michaux herbarium — instead it apparently is the procumbent species identified here as *G. brachypoda* (nothwithstanding an annotation by W.H. Duncan in 1977 as "*Galactia regularis* (L.) BSP. non sensu recent American authors."

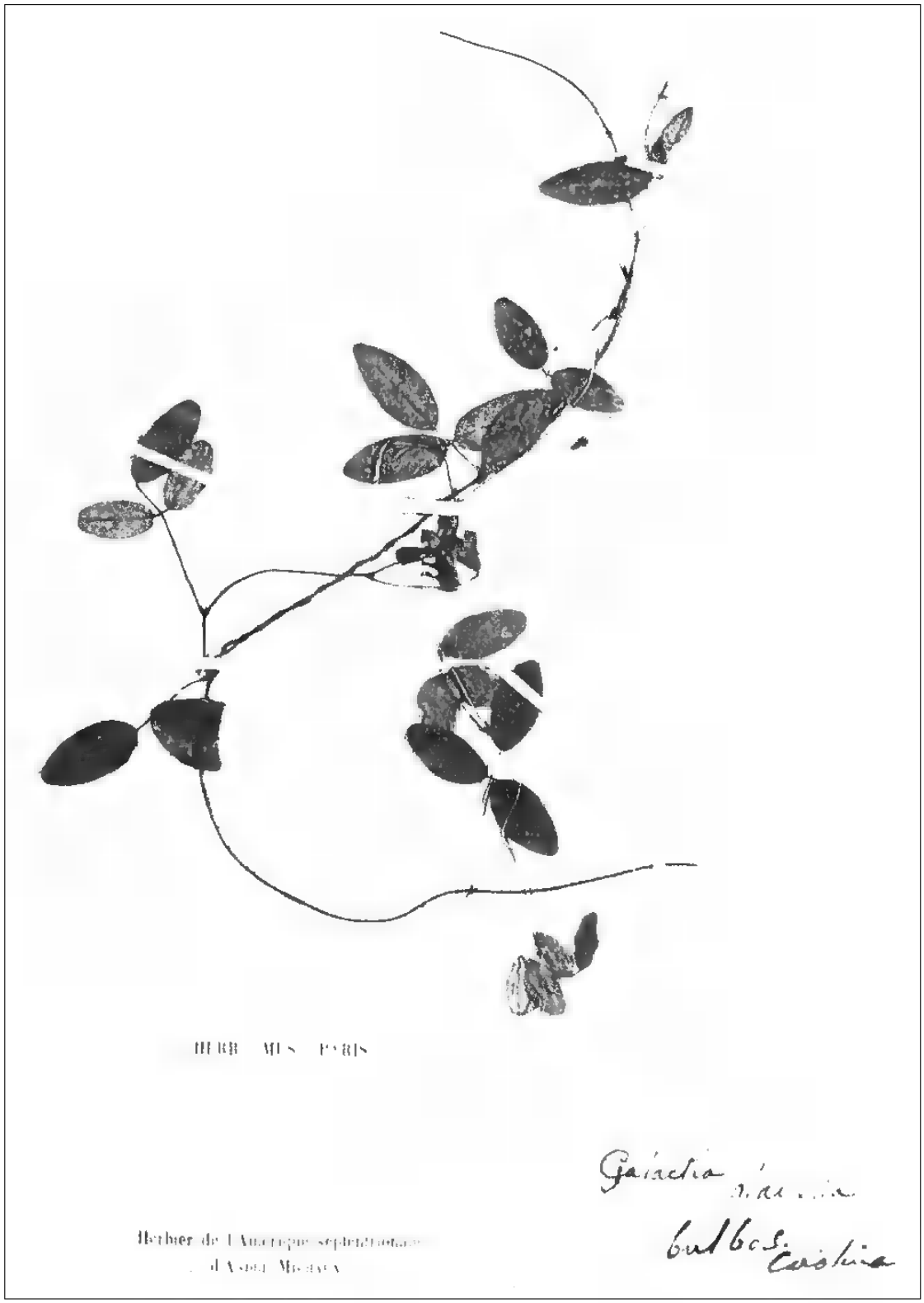

Figure 6. Holotype of *Galactia glabella* Michx. From microfiche.

Galactia macreei M.A. Curtis, Boston J. Nat. Hist. 1: 120. 1837. *Galactia pilosa* var. *macreei* (M.A. Curtis) Torrey & Gray, Fl. N. Amer. 1(2): 287. 1838. **TYPE: USA. North Carolina.** No type cited, but the original publication (Curtis 1837) is an enumeration of plants collected from around Wilmington, North Carolina. Probable holotype: North Carolina, no other data, *M.A. Curtis s.n.* (GH 00002425 digital image!). Torrey and Gray (1838), in making the combination at varietal rank, indicated that they saw a collection by Curtis, presumably GH 00002425.

A specimen at MO (216253/18547/2331175 digital image!) was collected in North Carolina (1847, *M.A. Curtis s.n.*) but is not type material because of the collection date. WIS 0255378 (digital image!) was collected in Louisiana apparently by *M.A. Curtis* (without a collection number or date) — it is *G. volubilis* but is not type material.

Galactia pilosa Nutt. var. *angustifolia* Torrey & Gray, Fl. N. Amer. 1(2): 287. 1838. **TYPE: USA. Florida.** Protologue: "Middle Florida, Croom! East Florida, Lieut. Alden!" Not seen. The name is provisionally placed in synonymy here.

Galactia volubilis (L.) Britt. var. *intermedia* Vail, Bull. Torrey Bot. Club 22: 508. 1895 [nom. illeg.]. **TYPE: USA.** "Florida to Louisiana." In synonymy of var. *intermedia*, Vail cited "*Galactia pilosa* γ *angustifolia* Torrey & Gray [1838]. Not *G. angustifolia* Kunth."

Perennial herbs, from a woody taproot. **Stems** climbing-twining, herbaceous, sparsely to moderately strigose with tightly to loosely appressed, retrorse hairs, sometimes glabrate. **Leaflets** 3, blades oblong to narrowly elliptic or narrowly lanceolate-elliptic, (10–)12–40(–45) x 5–15(–17) mm, herbaceous, glabrous to sparsely strigose adaxially, short-strigose abaxially, veins not raised, apices rounded to truncate or shallowly retuse. **Inflorescence** axis (10–)20–90(–240) mm, flowers solitary and axillary or 2–6(–10) in a reduced pseudoraceme on the distal 1/3–3/4 of the axis, sometimes fasciculate on the raceme. **Calyces** 6–8 mm, sparsely strigose to glabrate. **Corollas** 9–14 mm, pink to pink and purple. **Fruits** (20–)25–52 x 3–4 mm, straight, short-strigose. **Seeds** (5–)7–11.

Flowering (Apr–)May–Aug(–Sep). Swamp forest and borders, brackish marsh, ditches, shell mounds, hammock edges, live oak woods, pine and oak-pine woods, roadsides, cutover woods and other disturbed sites; 20–600 m. Ala., Fla., Ga., La., Miss., N.C., S.C., Tex. Map 12.

The distinction between *Galactia volubilis* and *G. regularis* is subtle but examination of hundreds of collections provides a basis for considering them separate entities. The two appear to be mostly distinct in their area of sympatry (*G. regularis* has a much wider geographic range), but intermediates are encountered. Flowering times coincide and there is overlap in habitat, allowing opportunities for hybridization, but the relative stability of the two forms suggests that some kind of reproductive isolation is in effect, perhaps post-zygotic.

The most prominent distinction between the two species is in leaflet shape, which usually provides evidence for a reasonable 'first sort' to species. Figures 7a, b, and c show a range of variation within each species, summarized in key couplet 20. Additionally, the leaves of *Galactia volubilis* tend to be thinner and glaucous on the abaxial surface.

Two collections from the same locality in Collier Co., Florida, have particularly large leaves but seem best identified as *Galactia volubilis*. Collier Co.: Fakahatchee Strand Preserve State Park, Gate 12, East Main Tram, strand swamp/logging tram, 23 Aug 2000, *Owen FS0210* (USF! and see digital image); Fakahatchee Strand Preserve SP, Gate 12, near entrance, strand swamp/logging tram, 25 Sep 1999, *Hattaway FS0211* (USF! and see digital image).

Figure 7a. Leaf variation in *Galactia regularis*. All examples from Alabama.

Figure 7b. Leaf variation in *Galactia volubilis*. All examples from Florida.

Figure 7c. Leaf variation in *Galactia volubilis*. All examples from Alabama.

15. **GALACTIA ERECTA** (Walt.) Vail, Bull. Torrey Bot. Club 22: 502. 1895. *Ervum erectum* Walt., Fl. Carol., 187. 1788. **NEOTYPE** (Ward 2008, p. 476): **USA. South Carolina**. Georgetown Co.: 5 mi S of Andrews, 10 Sep 1939, *R.K. Godfrey 147* (GH; isoneotypes: BH, DUKE, F, MO, NY, US).

Glycine stricta Hook., Comp. Bot. Mag. 1: 22. 1835. **TYPE: USA. Louisiana**. [St. Tammany Par.:] "Covington," 1831-32, *T. Drummond s.n.* (holotype: K?).

Galactia sessiliflora Torrey & Gray, Fl. N. Amer. 1(2): 288. 1838. **LECTOTYPE** (designated here): **USA. Florida**. Protologue: "Middle Florida, Dr. Chapman!" Florida, no other data, *A.W. Chapman s.n.* (GH 229576 digital image!; isolectotypes: GH digital image!, NY 2 sheets digital images). Also cited in the protologue was "Alabama, Dr. Gates!"

Perennial herbs, from a slender, irregularly thickened to neary moniliform taproot, also commonly producing very slender rhizomes. **Stems** mostly erect, not twining, usually alternately bent at nodes, (10–)20–30(–40) cm, herbaceous, glabrous or glabrate to sparsely strigose with closely appressed, retrorse hairs. **Leaflets** 3, blades oblong or narrowly oblong to narrowly elliptic or oblong-lanceolate, (15–)25–40(–50) x 7–18 mm, coriaceous, glabrous on both surfaces, venation closely reticulate (areoles isodiametric) and raised on both surfaces, with a thickened, continuous, marginal vein, apices rounded to obtuse, sometimes retuse. **Inflorescence** of axillary, subsessile fascicles, flowers solitary and axillary or 2–6 in a reduced pseudoraceme. **Calyces** 5–6 mm, short-strigose. **Corollas** 7–8 mm, pale purple to white (consistently white in Texas). **Fruits** 20–40 x 5–8 mm, densely hirsute. **Seeds** 6–10.

Flowering Apr–Jul. Longleaf pine, longleaf pine-oak scrub, oak scrub, wiregrass-slashpine woodland, pine flatwoods; 10–150 m; Ala., Fla., Ga., La., Miss., N.C., S.C., Tex. Map 13.

Galactia erecta is distinct in its erect habit, slender rhizomes, subsessile leaflets, and flowers in axillary-sessile clusters.

16. **GALACTIA JOSELYNIAE** Nesom, **sp. nov. TYPE: USA. Texas**. Brewster Co.: Big Bend National Park, Dead Horse Mountains, Passionflower Canyon, in wash bottom, 2 Aug 2003, *J. Fenstermacher 188* (holotype: SRSC). (Figures 8, 9, 10, 11, 12).

Similar to *Galactia wrightii* A. Gray in its mostly trailing stems and densely hairy leaves but different cauline vestiture with hairs either antrorsely or retrorsely oriented, leaflets smaller, broadly oblong to suborbicular with both surfaces gray-glaucous beneath the vestiture, and flowers smaller and fewer.

Perennial herbs from a woody taproot. **Stems** procumbent, perhaps weakly twining distally, herbaceous or lignescent proximally, loosely strigose with hairs antrorsely oriented (Brewster Co.) or retrorsely oriented (Jeff Davis Co.; Coahuila). **Leaflets** 3 (very rarely 5 on *Warnock 7917*), blades mostly broadly oblong-elliptic to suborbicular, also broadly oblong to broadly oblong-oblanceolate, (9–)11–29(–37) x 6–24(–34) mm, herbaceous, light green to glaucous (beneath the vestiture), densely hirsute-strigose to loosely strigose-sericeous on both surfaces, sometimes more densely so along the abaxial veins, veins strongly raised on abaxial surface but not adaxially, apices rounded to truncate or retuse. **Inflorescence** axis (1–)4–13(–15) cm, flowers solitary and axillary or 2–8 in a pseudoraceme, not fasciculate. **Calyces** 4–5 mm, loosely strigose. **Corollas** 6–8 mm, pink to rose-pink, drying dull blue-purple. **Fruits** 25–40 x 4–6 mm, straight, sparsely strigose with minutely filiform hairs. **Seeds** (4–)5–6.

Flowering Jun or perhaps much earlier–Aug. Gravelly canyon washes, from rock cracks and under shrubs (e.g., *Agave*, *Diospyros*, *Fallugia*, *Porophyllum*, *Viguiera*, *Yucca*); 600–1450 m; trans-Pecos Texas (Brewster and Jeff Davis cos.) and Coahuila, Mexico. Map 16.

Galactia joselyniae Nesom
FLORA OF THE DEAD HORSE MOUNTAINS
Big Bend National Park Texas
Brewster County
FABACEAE
Passionflower Canyon area In wash bottom
UTM Zone 13 693836 1E, 3243814 0N (NAD 83, GPS)
2 August 2003
J Fenstermacher 188
NPS Accession # BIBE-01491
NPS Catalog # BIBE 42106
SUL ROSS STATE UNIVERSITY
No.

Figure 8. Holotype of *Galactia joselyniae*.

Figure 9. *Galactia joselyniae*. Photo by Joselyn Fenstermacher, 2 Aug 2003, copied from color photo mounted with *Fenstermacher 961*.

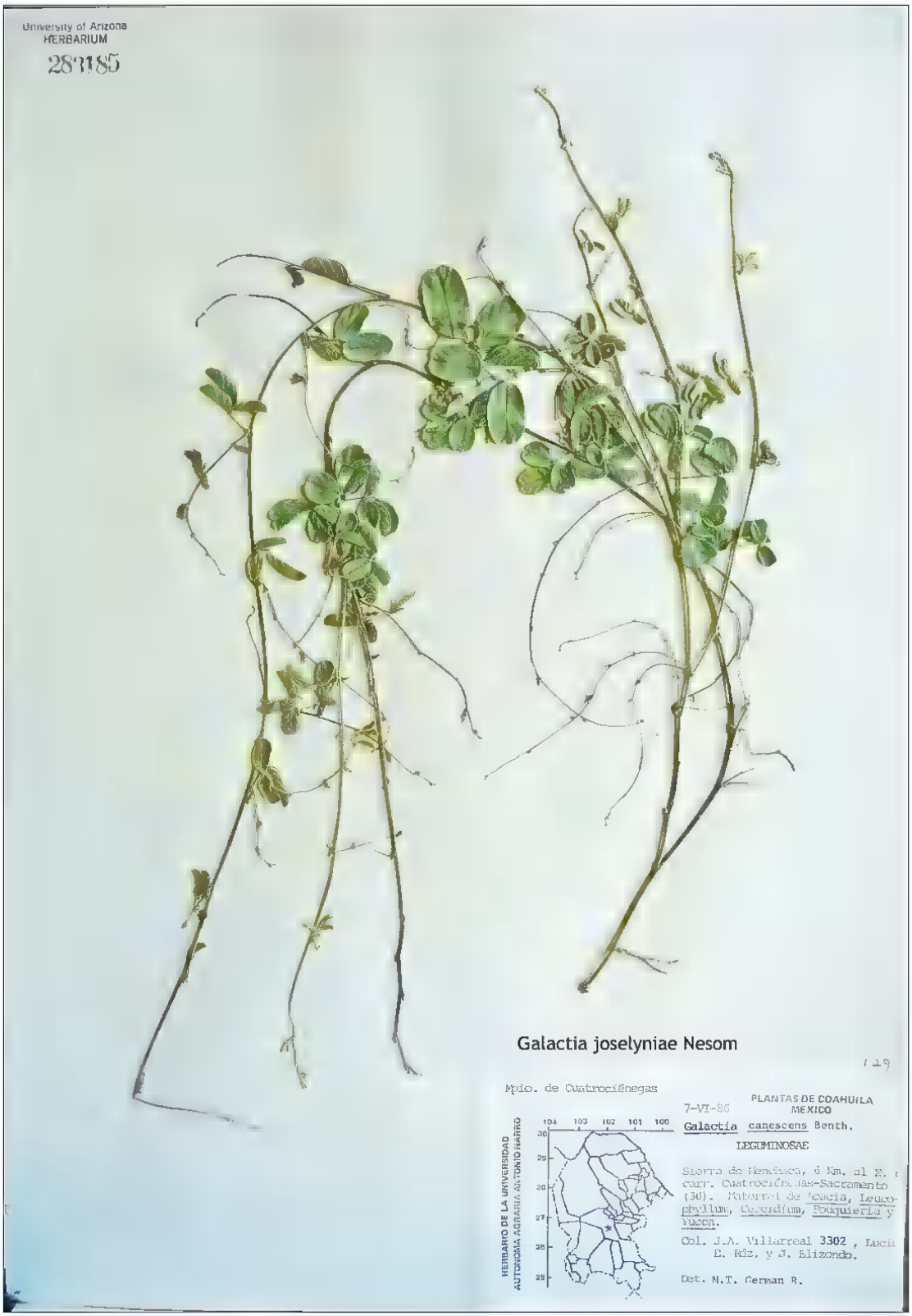

Figure 10. *Galactia joselyniae*. Coahuila, Mexico, *Villarreal 3302* (ARIZ).

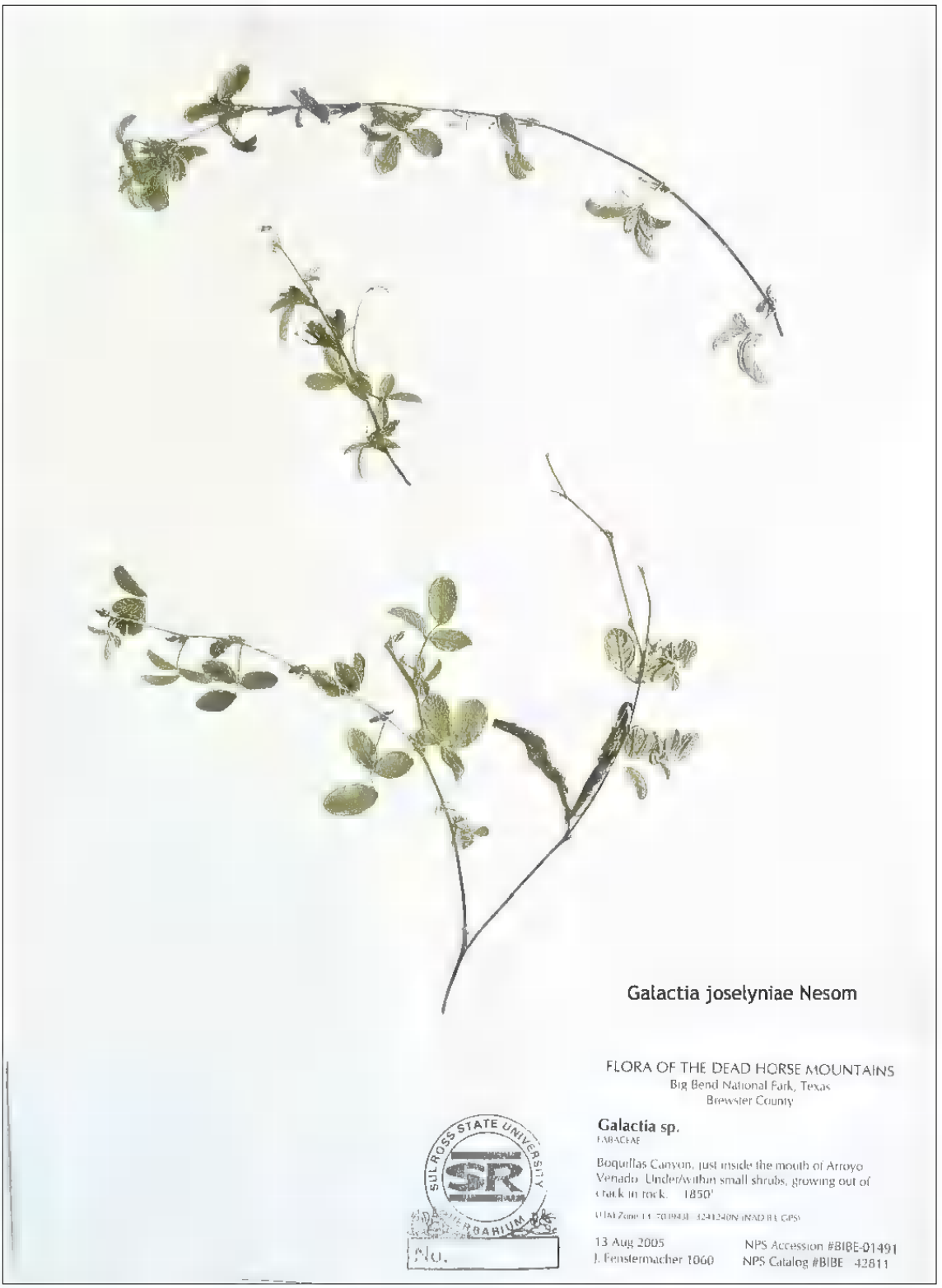
Galactia joselyniae Nesom
FLORA OF THE DEAD HORSE MOUNTAINS
Big Bend National Park, Texas
Brewster County
Galactia sp.
FABACEAE
Boquillas Canyon, just inside the mouth of Arroyo Venado. Under/within small shrubs, growing out of crack in rock. 1850'
13 Aug 2005
J. Fenstermacher 1060
NPS Accession #BIBE-01491
NPS Catalog #BIBE 42811
SUL ROSS STATE UNIVERSITY
HERBARIUM
No.

Figure 11. *Galactia joselyniae*. Brewster Co., Texas, *Fenstermacher 1060* (SRSC).

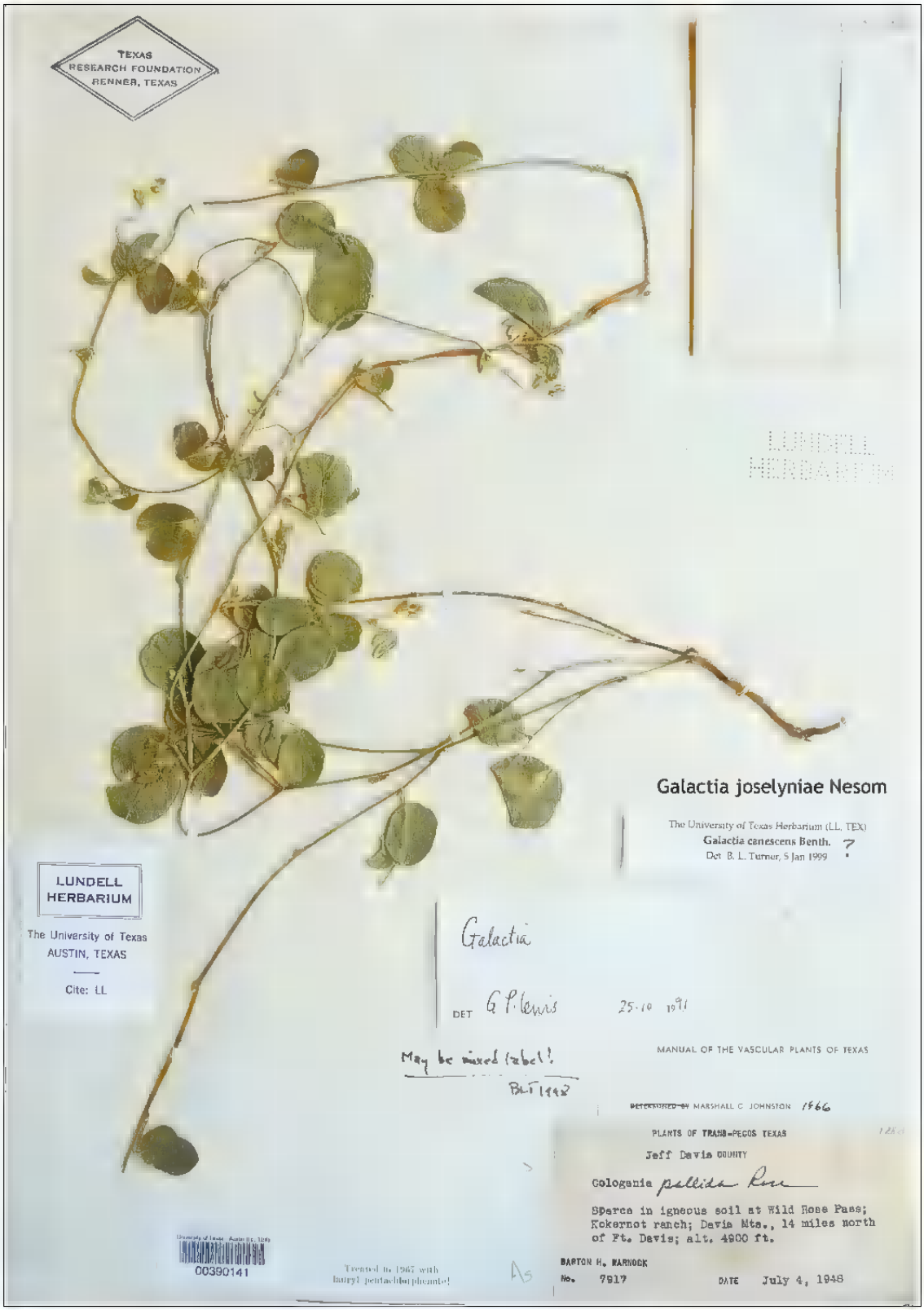

Figure 12. *Galactia joselyniae*. *Warnock 7917* (LL), from Wild Rose Pass in Jeff Davis Co., Texas.

Additional collections examined. **MEXICO. Coahuila**. Sierra de Menchaca, 6 km N carr. Cuatrocienegas-Sacramento (30), matorral de *Acacia*, *Leucophyllum*, *Cercidium*, *Fouquieria*, y *Yucca*, 7 Jun 1986, *Villarreal 3302 et al.* (ARIZ). **USA. Texas**. Brewster Co.: Big Bend National Park, Dead Horse Mountains: Passionflower Canyon, in western half of wash ca. 200 ft below constriction, just where *Bouchea spauthulata* first occurs mid-wash, bottom of wide, open, gravel wash, under clump of *Yucca torreyana*, *Parthenium incanum*, and *Fallugia paradoxa*, 2750 ft, 5 Aug 2005, *Fenstermacher 940* (SRSC); Passionflower Canyon, S end, below first constriction but still within canyon, E side of wash, a little higher that main channel, only occasionally flooded, with *Viguiera stenoloba*, *Porophyllum scoparium*, *Agave lechuguilla*, 5 Aug 2005, *Fenstermacher 961* (SRSC); Boquillas Canyon, just inside mouth of Arroyo Venado, under and within small shrubs, growing out of crack in rock, 1850 ft, 13 Aug 2005, *Fenstermacher 1060* (SRSC); Boquillas Canyon, within first half mile of Cow Canyon, in wash gravel, 1800 ft, 28 Oct 2005, *Fenstermacher 2141* (SRSC); Boquillas Canyon, within first half mile of Arroyo Venado, with *Diospyros*, *Croton*, *Acalypha*, 1800 ft, 27 Oct 2005, *Fenstermacher 2090* (SRSC). Jeff Davis Co.: Davis Mts., Wild Rose Pass, Kokernot Ranch, 14 mi N of Ft. Davis, sparse in igneous soil, 4900 ft, 4 Jul 1948, *B.H. Warnock 7917* (LL, SMU, SRSC).

The epithet commemorates Joselyn Fenstermacher, who made the Brewster County collections in her study (as a student at Sul Ross State University) of the flora of the Dead Horse Mountains (Fenstermacher et al. 2008). She is still exploring the landscape (Fenstermacher 2015). Earlier collections apparently of the same species were made by Jose Villarreal in central Coahuila and by Barton Warnock further north in Jeff Davis Co., Texas, but the nature and reality of the species would not have been possible to appreciate without the Fenstermacher collections. Fenstermacher et al. (2008, p. 701) noted that the Dead Horse plants were perhaps an undescribed species: "It does not fit descriptions of known Texan taxa (B. Turner pers. comm.) and awaits review when appropriate herbarium specimens become available."

The Warnock collection from Wild Rose Pass (along Hwy 17 in Jeff Davis County) was identified in 1955 by B.L. Turner as "Galactia warnockii Turner" sp. nov. and then in 1994 by J. Henrickson as "Galactia warnockii Turner ex Henrickson" sp. nov. — but perhaps neither at the time felt comfortable in formally describing a new species based on a single collection from a well-explored and collected area. The leaflets are broader than those from the region of the type collection and from Coahuila, but other features are those of *G. joselyniae*.

The Dead Horse Mountains are parallel to the western boundary of Big Bend National Park, immediately adjacent to northwestern Coahuila (see Fenstermacher et al. 2008). "Populations have been found in several southern [Dead Horse] locations and the plant was encountered more commonly near the Rio Grande within side drainages of Boquillas Canyon" (Fenstermacher et al. 2008, p. 701). The Mexican collection was made in central Coahuila, about 300 kilometers south of the Brewster County sites — the occurrence of *Galactia joselyniae* in the area between should be expected.

17. **GALACTIA WRIGHTII** A. Gray, Smithsonian Contr. Knowl. [Pl. Wright. 1] 3(5): 44. 1852. *Odonia wrightii* (A. Gray) Rose, Contr. U.S. Natl. Herb. 10: 102. 1906. **TYPE: USA. Texas**. [Jeff Davis Co.:] Outside of Fort Davis, valley of the Limpia, 23 Aug 1849, *C. Wright 111* (holotype: GH digital image!; isotype: NY digital image!).

Galactia tephrodes A. Gray, Smithson. Contr. Knowl. [Pl. Wright.] 5(6): 34. 1853. **TYPE: USA. New Mexico**. [Hidalgo Co.:] Protologue: "Mountain-sides, near Conde's Camp, between the copper mines and Chiricahui Mountains, New Mexico, Aug.," [ca. 31 Aug] 1851, *C. Wright 956* (holotype: GH digital image!; isotypes: GH digital image!, NY digital image!, PH digital image!, US digital image!). All are labeled as "Wright 956," but only the NY sheet has locality data matching the protologue. The PH label says only "Coppermines;" labels for the

other sheets, including the holotype, have no locality indicated. Conde's Camp was about 20 miles west or southwest of Lordsburg in Hidalgo County, near the Arizona border (as inferred from Wooton 1906).

Galactia wrightii var. *mollissima* Kearney & Peebles, J. Wash. Acad. Sci. 29: 485. 1939. **TYPE**: **USA. Arizona**. Santa Cruz Co.: Near Patagonia, 7 Aug 1927, *R.H. Peebles, G.J. Harrison, & T.H. Kearney 4657* (holotype: US digital image!).

Perennial herbs, arising from an woody taproot. **Stems** first procumbent, then weakly twining distally, strongly lignescent, densely to sparsely strigose with retrorsely appressed to slightly spreading hairs. **Leaflets** 3, blades oblong-elliptic to elliptic-ovate, 15–48 x 5–18 mm, herbaceous, adaxially sparsely to densely short strigose-sericeous with closely appressed hairs to pubescent with soft, spreading-erect hairs, moderately to densely strigose-sericeous and glaucous abaxially, sometimes sparsely strigose to glabrous adaxially, veins not raised, apices rounded to obtuse or shallowly retuse. **Inflorescence** axis 35–200(–250) mm, flowers (2–)5–18(–30) in a pseudoraceme, commonly fasciculate on the raceme, axis rarely 10 mm and 2–3 flowered. **Calyces** 5–7 mm, loosely short-strigose to hirsute-pubescent. **Corollas** 11–12 mm, pink to purple-rose to lavender. **Fruits** 25–50 x 4–5 mm, straight, moderately to densely strigose to strigose-sericeous. **Seeds** (3–)5–9.

Flowering May–Aug. Grassland, desert scrub, oak-juniper and oak woodland, granite crevices, igneous talus, among boulders, gravelly alluvium; 800–2100 m; Ariz., N.Mex., Tex.; Mexico (Chihuahua, Sonora). Map 14.

Galactia wrightii is characterized by twining stems, mostly oblong-elliptic leaflets with glaucous abaxial surfaces, long inflorescences with numerous flowers and relatively large corollas, and strigose-sericeous fruits. The type of var. *mollissima* is a plant with vestiture more spreading than normal — such variants are scattered through the range in Arizona, as cited by Kearney and Peebles, as well as in Texas.

Plants in southwestern New Mexico and southeastern Arizona (especially the Huachuca Mountains but not the Chiricahua Mts) tend to have reduced vestiture — the leaves sometimes completely glabrous. Such plants extend southward in Mexico along the Chihuahua-Sonora border region. Intermediates are numerous, however, especially in Arizona, and no distinct boundary seems evident.

18. **GALACTIA CANESCENS** Benth., Ann. Wiener Mus. Naturgesch. 2: 126. 1838. **LECTOTYPE** (designated here): **USA. Texas**. Protologue: "Texas. Drummond." Without other data, *T. Drummond 146* (holotype: W digital image!; isotypes: GH-2 sheets digital images!, US ex herb. Lausanne digital image!). One of the GH sheets has no collection number.

Heterocarpaea texana Scheele, Linnaea 21: 468. 1848. **TYPE**: **USA. Texas**. [Comal Co.:] Protologue: "Auf Felsboden südlich von Neubraunfels [On rocky ground south of New Braunfels]: Lindheimer. Juli." Field label (GH): "On rocky soil, part of the fruits subterraneous, stem prostrate, radiant, N. Br. [New Braunfels], Texas, July 46, F.L. 266." Printed label: Jul 1846. F. Lindheimer Fasc. III, 370 (holotype: CAS?; isotypes: GH digital image!, NY digital image!, P-4 sheets digital images!, PH 3 sheets digital images!, SI [ex P] digital image!, US digital image!).

Perennial herbs, from slender, elongate woody taproot, commonly producing filiform rhizomes at the nodes, these producing 1-seeded subterranean flowers and fruits. **Stems** procumbent, not twining, lignescent proximally, moderately strigose with loosely appressed, retrorse hairs. **Leaflets** 3, blades broadly oblong to oblong-obovate, olong-elliptic, or suborbicular, 11–35(–42) x 8–30(–35) mm, herbaceous, blue-green-glaucous and densely strigose abaxially, sparsely strigose adaxially with closely appressed hairs, veins not raised, apices rounded to flat or shallowly retuse.

Inflorescence axis 60–120 mm, flowers 5–8 in a pseudoraceme. **Calyces** 5–8 mm, hirsute to strigose-hirsute. **Corollas** 9–11 mm, pink to pink-red or light purple. **Fruits** 30–50 x 6–9 mm, straight or slightly curved, densely strigose-sericeous. **Seeds** 1–5.

Flowering Apr–Oct. Sandy prairies, dunes, sand mounds, sandy roadsides, disturbed sites, sandy loam, alluvial sand; 10–150 m; Tex.; Mexico (Tamaulipas). Map 15; Mexican distribution now shown.

Galactia canescens is characterized by its procumbent, strigose stems rooting at the nodes, slender rhizomes often bearing subterranean flowers and fruits, and broadly oblong to suborbicular leaflets with glaucous and densely strigose abaxial surfaces. The subterranean, cleistogamous flowers apparently are unique in the genus.

19. **GALACTIA TEXANA** (Scheele) A. Gray, Boston J. Nat. Hist. 6(2): 170. 1850. *Lablab texanus* Scheele, Linnaea 21: 467. 1848. **TYPE: USA. Texas**. Protologue: "Prope Neubraunfels leg. Lindheimer. Julio." Jul 1846, *F. Lindheimer Fasc. III 368* (holotype: CAS or W?; isotypes: NY-fragments [origin unspecified] digital image!, US digital image!, SI-fragments ex GH, US, W digital images!).

Perennial herbs, arising from a slender, elongate, woody taproot. **Stems** climbing-twining, lignescent proximally, hirsute-strigose to strigose with loosely appressed, retrorse hairs. **Leaflets** 3, blades elliptic to broadly elliptic or oblong-elliptic, (15–)20–42 x 10–25(–32) mm, herbaceous, not glaucous, glabrous to sparsely strigose adaxially, sparsely strigose abaxially with closely appressed hairs to softly hirsute with ascending hairs, veins raised or not on both surfaces, apices obtuse to rounded or shallowly retuse. **Inflorescence** axis 0–4(–40) mm, flowers solitary and axillary or 2–4 in a reduced pseudoraceme. **Calyces** ca. 6 mm, loosely strigose to hirsute-strigose or hirsute. **Corollas** 8–11 mm, pink, rose, reddish, or purple-cream. **Fruits** 30–60 x 4–6 mm, falcate, sparsely minutely strigulose with closely appressed hairs. **Seeds** (3–)6–10.

Flowering Jun–Jul(–Aug). Oak-juniper, ash-juniper, and oak woodlands, valley and canyon bottoms, roadbanks, gravelly limestone outcrops and slopes, streamsides and terraces, limestone alluvium, rocky clay; 350–500 m; Tex.; Mexico (Coahuila, Nuevo Léon, Tamaulipas), South America (Argentina). Map 16; Mexican distribution not shown.

Galactia texana is characterized by its twining stems, short, few-flowered inflorescence, and falcate fruits. Burkart (1971, p. 708) described *G. texana* var. *degasperii* Burkart (*A. Burkart 20288*, SI digital image!) from several collections from two adjacent provinces (Chaco and Formosa) of Argentina, apparently allopatric with var. *texana* in Argentina (Catamarca, Córdoba, La Rioja, Salta, San Luis, Santiago del Estero, and Tucumán provinces, as cited by Burkart). It differs from var. *texana* in its longer stems, smaller corollas (5–8 mm long vs. 10–13 mm for var. *texana* in Argentina, 8–11 mm in Texas) and strigose-sericeous fruits (vs. minutely strigulose elsewhere). Whether they intergrade in Argentina is not clear, and the evolutionary-taxonomic status of var. *degasperii* is in need of study.

20. **GALACTIA PINETORUM** Small, Fl. Miami 93, 200. 1913. **TYPE: USA. Florida**. Miami-Dade Co.: In pinelands, between Cocoanut Grove and Cutler, 9 May 1904, *J.K. Small* and *P. Wilson 1592* (holotype: NY digital image!).

Perennial herbs, from a woody, elongate, cylindric to fusiform or obfusiform taproot. **Stems** procumbent, not twining, herbaceous, minutely and sparsely strigulose with retrorse or rarely antrorse hairs. Leaflets 3, blades linear-oblong or narrowly oblong to narrowly lanceolate, narrowly elliptic-lanceolate, or linear-elliptic, 20–55 x 2–8(–11) mm, coriaceous, glabrous adaxially, glabrate

to sparsely strigulose abaxially, sometimes glaucous, venation prominently raised on both surfaces, apices rounded to obtuse. **Inflorescence** axis 30–150 mm, flowers solitary and axillary or 2–8(–10) in a reduced pseudoraceme, usually in distal 1/2–1/4 of axis. **Calyces** 5–9 mm, strigulose. **Corollas** 11–15 mm, blue to purple or purplish or pink-purple. **Fruits** 25–50 x 4 mm, straight, densely strigose to strigulose with minute hairs. **Seeds** 5–7.

Flowering all year. Disturbed sites, among palmettos, dry sand; 0–25 m; Fla. (Brevard, Dade, and Monroe cos.). Map 10.

Collections examined. **Florida**. Brevard Co.: 4 mi N of Eau Gallie, 19 Apr 1957, *Melvin s.n.* (NCU). Dade Co.: Ludlam Pineland Preserve, SW 67 Ave and ca. 146 St., common in pine rockland, 8 May 1998, *Bradley 1670* (USF); Miami, 1 Apr 1903, *Britton 2270* (USF); Coral Gables, Acona at Red Road, vacant pine lot, [date] *Broome s.n.* (USF - 2 sheets); Univ. of Miami campus under pine, 10 Sep 1966, *Broome s.n.* (USF); Southern part of peninsula, May-Jun 1904, *Eaton 987* (LL, USF); edge of woods on Jenning's Estate, near FTG Lab, 1 Jul 1974, *Fawcett s.n.* (NCU); pineland remnant at vic. of SW 50 Terr and 69 Ave, Miami, 11 May 1975, *Hill 2979* (NCU); SW of Homestead, Everglades Natl. Park, 30 Mar 1963, *Lakela 25734* (USF); vicinity of Old Cutler Road and Fairchild Tropical Garden, margin of pineland, pond terrace, 17 Jul 1964, *Lakela 27269* (USF); Coral Gables, vicinity of Old Cutler Road, few plants over Miami oolite, 3 Apr 1965, *Lakela 28438* (USF); Homestead, W side of Krome Ave., wooded, vacant lot, 1 Jul 1965, *Lakela 28773* (USF); Homestead, unbuilt lot, pineland, 26 Apr 1966, *Lakela & Long 29704* (USF); Buena Vista, climbing over weeds, 8 Feb 1930, *Moldenke 580a* (LL, MU-fide M. Vincent); Buena Vista, dry sandy soil among palmettos, 18 Dec 1929, *Moldenke 268* (LL, MU-fide M. Vincent). Monroe Co.: Long Pine Key, 22 Apr 1960, *Craighead s.n.* (USF).

Galactia pinetorum is distinctive in its procumbent (non-twining) stems usually with retrorse hairs, very narrow leaflets with raised venation, and relatively large flowers. Stems of Moldenke collections have antrorsely oriented hairs — this variation analogous that seen also in *G. brachypoda*, *G. joselyniae*, *G. microphylla*, and *G. smallii*. The other linear-leaflet species of south Florida, *G. grisebachii*, has twining stems with consistently antrorse hairs, leaflets without prominently raised venation, and smaller flowers.

21. **GALACTIA GRISEBACHII** Urb., Symb. Antill. 5: 372. 1908 [nom. nov., replacing *G. stenophylla* Urb.]. *Galactia stenophylla* Urb., Symb. Antill. 2: 313. 1900 (not *G. stenophylla* Hook. & Arn., Bot. Misc. 3: 182. 1833, from Uruguay = *Collaea stenophylla*). **LECTOTYPE** (designated here): **CUBA**. No other locality data, 1860-1864, *C. Wright 2335* (BREM digital image! Figure 12a; isolectotypes: B [presumably destroyed], K digital image! Figure 12b, US digital image!, W). Protologue: "Hab. in Cuba: Wright n. 2335 p.p. (hb. Brem. [BREM], Krug et Urb. [B], Vindob. [W])." Figure 13.

Dolichos filiformis L., Syst. Nat., ed. 10. 2: 1163. 1759 [not *Galactia filiformis* (Jacq.) Benth. 1840]. **LECTOTYPE** (Fawcett & Rendle in *Fl. Jamaica* (ed. 2) 4: 58. 1920): **JAMAICA**. No other data (LINN 900.13 digital image!). Protologue: "D. foliolis linearibus obtusis mucronatis glabris subtus pubescentibus. *Brown jam.* 294. n. 6." Browne (1756) noted that "This little plant is frequent about *Old-harbour*."

Galactia angustifolia var. *retusa* Wright ex Griseb., Cat. Pl. Cub., 75. 1866. *Galactia parvifolia* A. Rich. var. *heterophylla* Urb., Symb. Antill. 2: 315. 1900 (nom nov. illeg., apparently intended as a substitute for *G. angustifolia* var. *retusa*, which was listed in synonymy). **TYPE: CUBA**. GH label: "prope villam Monte Verde dictam, Cuba Orientali, Jan.-Jul. 1859," *C. Wright 1179* (holotype [fide annotation by R. Howard 1984]: GOET digital image!; isotypes: GH digital image!, US digital image!). The GOET label data give only "in Cuba Orientali, ... 1860," *C. Wright 1179*.

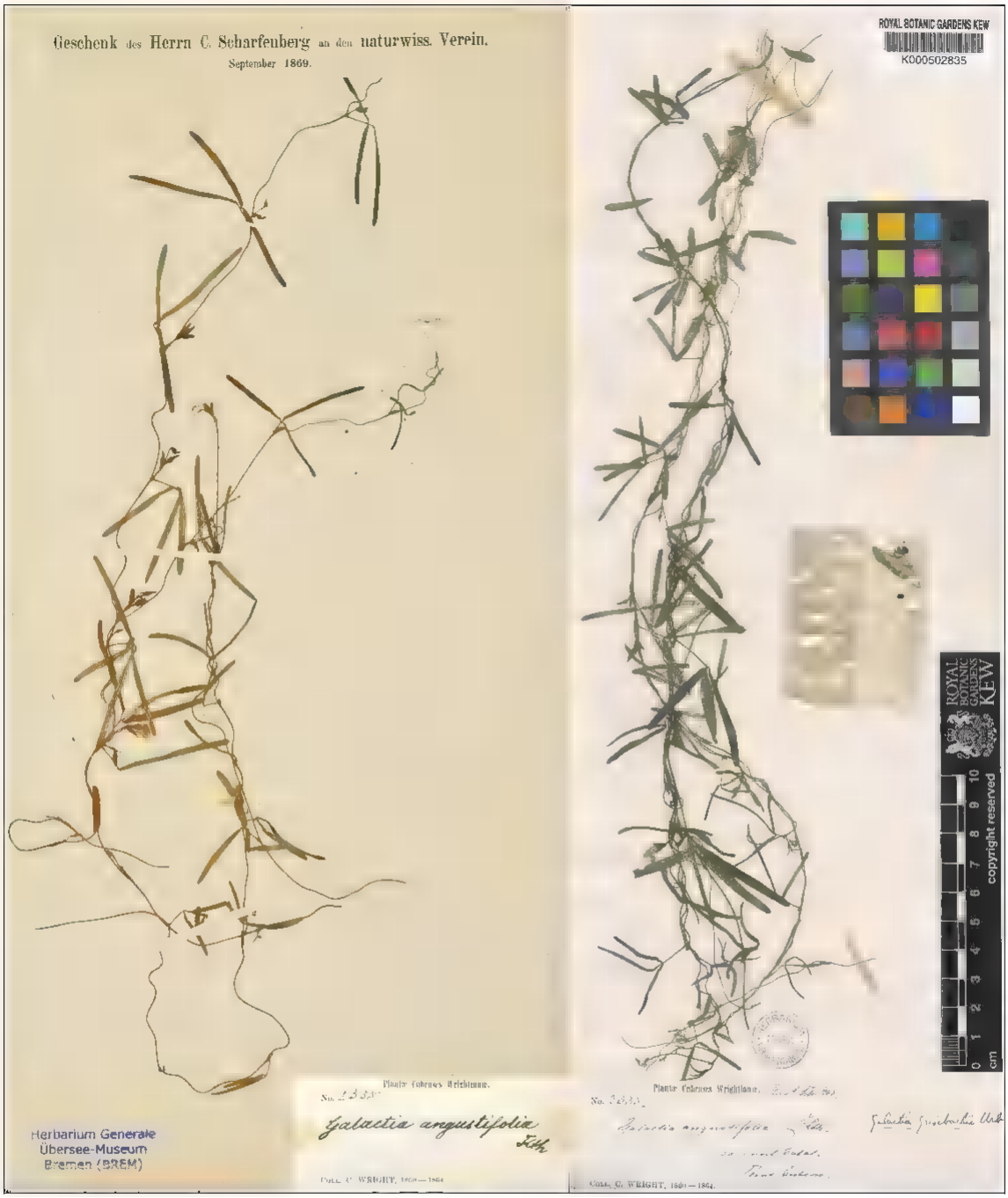

Figure 13. *Galactia grisebachii* Urb. a. Lectotype, BREM b. Isolectotype, K.

Perennial herbs, from an elongate taproot. **Stems** climbing-twining, filiform, herbaceous, sparsely and minutely strigose with antrorse hairs. **Leaflets** 3, blades linear-oblong to narrowly oblong or narrowly elliptic, (10–)15–40 mm x 2–4(–6) mm, herbaceous, sparsely strigose to glabrous adaxially, weakly glaucous and sparsely minutely strigose abaxially, veins not raised, apices rounded to obtuse. **Inflorescence** axis 10–40(–130) mm, flowers solitary and axillary or 2–5(–10) in reduced

pseudoracemes. **Calyces** 5–6 mm, strigose. **Corollas** 7–9 mm, pink to blue, purple, or lavender. **Fruits** (20–)25–45 x 3–5 mm, straight, sparsely strigose. **Seeds** (3–)8–10.

Flowering all year. Pinelands, pine-palmetto, hammocks, weedy grassland, sandy fields, beaches; 0–20 m; Fla. (Dade, Lee, and Monroe cos.); West Indies (Bahamas?, Cuba!, Hispaniola!, Jamaica!, Puerto Rico?). Map 10.

Collections examined. USA. Florida. Dade Co.: Everglades Natl. Park, Omissa Bauer Hammock, 26 Sep 1961, *Craighead s.n.* (USF); NE side of Homestead by US 1, oolitic clearing in slash pineland, 19 Sep 1973, *Kral 51831* (VDB); ca. 2 mi due W of Florida City, in slash pine-palmetto, 23 Aug 1980, *Kral 66245* (VDB); Univ. of Miami campus, bordering uncut RR tracks, 10 Sep 1966, *Lakela 30212* (USF). Lee Co.: Sanibel Island, sandy field, 16 Oct 1969, *Radford 45549* (NCU). Monroe Co.: Big Pine Key, 5 Mar 1943, *Cornman 2104* (MO); Big Pine Key, along E-W street along N side of prison, 0.5 mi N of US 1, weedy roadside along open woodland, 18 Aug 1987, *Hansen & Richardson 11448* (USF); Florida Bay, Cape Sabel, Middle Cape, sandy beach, 7 May 1965, *Lakela 28582* (USF-2 sheets); Big Pine Key, 9 Jun 1973, *Lakela 32215* and *32215A* (USF); Big Pine Key, N end, pineland, 22 Oct 1965, *Lakela 29286* (USF); S end of Big Pine Key, martime strand, 6 Aug 1966, *Long 2014* (USF); Big Pine Key, pineland and hammock near Watsen's Hammock, 11 Feb 1967, *Long 2453* (USF); central part of Big Pine Key, pineland, 18 Dec 1974, *Poppleton & Shuey s.n.* (USF); Big Pine Key, pineland-palmetto forest, *Radford 45853* (NCU); Big Pine Key, along Fla 940, 1.8 mi NW of US 1, pineland, 14 Mar 1982, *Sauleda 7039* (USF); E end of Packet Key, 17 May 1965, *Wiggins 20079* (USF).

These consistently linear-oblong-leaflet plants, easily recognized, of Florida have previously been identified as *Galactia parvifolia*, but in the interpretation here, that name has been misapplied. *Galactia parvifolia* (Figure 14) has broadly oblong to oblong-elliptic leaflets from base to the top of the stem, distinct from the consistent linear shape of the Florida plants. Various Caribbean treatments have noted that leaflet shape is variable within *G. parvifolia*. In the Dominican Republic, Cuba, and the Bahamas (Liogier 1985; Sauget & Liogier 1951; Beyra M. et al. 2005; Correll & Correll 1982), leaflets have been described as linear to oblong, elliptic-oblong, ovate, and suborbicular, without qualification as to position of the leaves on the stem.

Galactia parvifolia A. Rich., Hist. Phys. Cuba, Pl. Vasc. 1: 414. 1845. **Type: CUBA.** [**Prov. Pinar del Río**]. "Crescit in Vuelta de Abajo," no locality data except "Cuba" on the specimen, *Ramon de la Sagra s.n.* (probable holotype, but "isotype" as labeled: P, cat. P00798723 digital image!; **Figure** 13). P00798723 has twining stems, small and oblong-elliptic leaflets, obtuse to truncate at both ends and apically emarginate, short-pedunculate and 2-5-flowered racemes, and narrow and villous legumes. Richard's protologue essentially matches P00798723 and notes that *Galactia parvifolia* is particularly distinguished by the small, elliptic leaflets, presumably hence the deriviation of the epithet. A different specimen (P00798722 digital image!), also collected in "Cuba" by de la Sagra and identified on the sheet as the "holotype" of *G. parvifolia*, has trailing (non-twining) stems, is completely leafless (leaves have fallen off), and the fruits are broad and apparently nearly glabrous — it appears to be a different species from P00798723 and is not the plant described by Richard.

A sheet at F (936748) was annotated by W.T. Gillis in 1977 as "holotype fragment" of *Galactia parvifolia* A. Rich — it includes a few short, oblong to oblong-lanceolate leaflets, a segment of an elongate inflorescence, pieces of a broad pod, and several seeds. The relatively broad fruits and long inflorescence of the F fragments are similar to P00798722, not to P00798723. One might suspect, however, that the leaves were taken from P00798723 and that the F sheet is an admixture.

Figure 14. Probable holotype of *Galactia parvifolia* A. Rich (see text).

In the original description of *Galactia stenophylla*, Urban contrasted the "obtuse to rotundate" leaflets of basal leaves with the linear ones of cauline leaves. Similarly, Small (1913b) noted that for Florida plants the lower cauline leaflets are broader than those of distal leaves, "varying from ovate or oval to obovate," but all Florida collections I have seen (as cited above) have uniformly linear leaflets, from proximal to distal leaves. For Jamaica, Adams (1972) described leaflets of *G. parvifolia* as 2–3 mm wide — which is characteristic of a linear to linear-oblong shape and within the morphological range of the Florida plants. In fact, *Dolichos filiformis* L., the earliest name for these linear-leaflet plants, was described from Jamaica — it is blocked from transfer to *Galactia* by the later combination *Galactia filiformis* (Jacq.) Benth. from 1837, representing a heterotypic and more distantly related species of Hispaniola.

In the protologue of *Galactia stenophylla*, Urban noted that it was perhaps nothing but a variety of *G. parvifolia* ("Fortasse nihil aliud nisi varietas G. parvifoliae A. Rich."), but eight years later, in providing a replacement name for *G. stenophylla*, he still considered it worthy of recognition. Urban's course is followed here in treating the linear-leaflet plants, which grow at least in Cuba, Hispaniola, Jamaica, and Florida, as a species distinct from *G. parvifolia*.

EXCLUDED SPECIES

Galactia watsoniana Holmes & Singhurst (2008) is a synonym of *Cologania pallida* Rose. It was described from Bandera County in south-central Texas, from the Love Creek Preserve of the Nature Conservancy of Texas. Plants of essentially identical morphology occur disjunctly separated from Bandera County in Jeff Davis and Brewster counties, Texas, and equally close or closer populations occur in Coahuila, Mexico.

ACKNOWLEDGEMENTS

I am especially grateful to Stephen Harris, OXF Curator, for sending photos of the OXF specimen putatively associated with the Hortus Elthamensis illustration of *Hedysarum volubile*, to Fernanda Rodrigues at BREM for sending a photo of the *Galactia stenophylla* lectotype, to the staff at GH for information on specimens there, to Tom Zanoni at NY for critical observations on the vestiture of the type of *Galactia brachypoda*, to Jim Zarucchi at MO for an image of the P holotype of *Galactia glabella*, to ARIZ, SRSC, and TEX-LL for loans (studied at BRIT), and to staff at ASU, BRIT-SMU-VDB, MO, NCU, TEX-LL, and USF for hospitality and help during study there. Study of specimen images on online databases of NLU, LSU, USF, FLAS, FSU, and FTG were remarkably helpful. This study was supported in part by the Flora of North America Association. Before the completion of this study, I annotated specimens as *G. volubilis* (these are *G. regularis*) and *G. macreei* (these are *G. volubilis*).

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APPENDIX. **Worldwide species of *Galactia* (identified only by epithet).** Underlined names appear in a preceding geographic area and are not counted again. In this account, the genus includes 111 total species.

USA (21 species): brachypoda, canescens, elliottii, erecta, fasciculata, floridana, grisebachii, heterophylla, joselyniae, longifolia, marginalis, microphylla, minor, mollis, pinetorum, regularis, smalli, striata (incl. spiciformis), texana, volubilis, wrightii

WEST INDIES (45 species; 4 also in USA = 41): acunana, bahamensis, brachyodon, buchii, caimitensis, carnea, combsii, cuneata, dictyophylla, dubia, earlei, eggersii, excisa, filiformis, fuertesii, galactioides, glaucescens, grisebachii, herradurensis, isopoda, jenningsii, jussiaeana, laxiflora, leucocarpa, lignosa, longiflora, longifolia, maisiana, minutifolia, monophylla, nummularia, ocoana, parvifolia, pendula, revoluta, rotundata, rubra, rudolphoides, sangsterae, savannarum, schomburgkii, striata, suberecta, synandra, uniflora

MEXICO (17 species; 7 also in USA and WEST INDIES = 10): acapulcensis, acuminata, argentea, belizensis, brachystachys, canescens, densiflora, discolor, heterophylla, incana, joselyniae, multiflora, retusa, striata, texana, viridiflora, wrightii

CENTRAL AMERICA (9 species; 5 also in areas above = 4): acapulcensis, anomala, argentea, belizensis, discolor, multiflora, serpentina, sparsiflora, striata

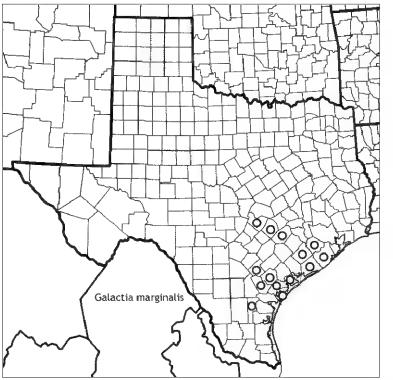
SOUTH AMERICA (39 species; 7 also in areas above = 32): augustii, australis, benthamiana, boavista, bullata, cordifolia, crassifolia, decumbens, dimorpha, dimorphophylla, douradensis, dubia, eriosematoides, fiebrigiana, glaucescens, glaucophylla, gracillima, grewiifolia, heringeri, hoehnei, irwinii, jussiaeana, lamprophylla, latisiliqua, lindenii, longifolia, marginalis, martii, martioides, montana, neesii, peduncularis, pretiosa, remansoana, shumbae, stereophylla, striata, tenuiflora, texana, weddelliana

AUSTRALIA (3 species; 1 also in areas above = 2): megalophylla, muelleri, tenuiflora

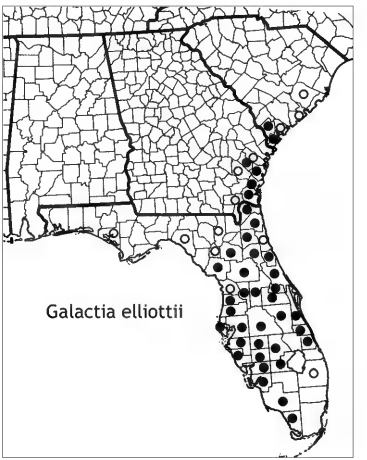
ASIA (2 species; 1 also in areas above = 1): tashiroi, tenuiflora

AFRICA (1 species, also in areas above = 0): tenuiflora

Map 1.



Map 2.



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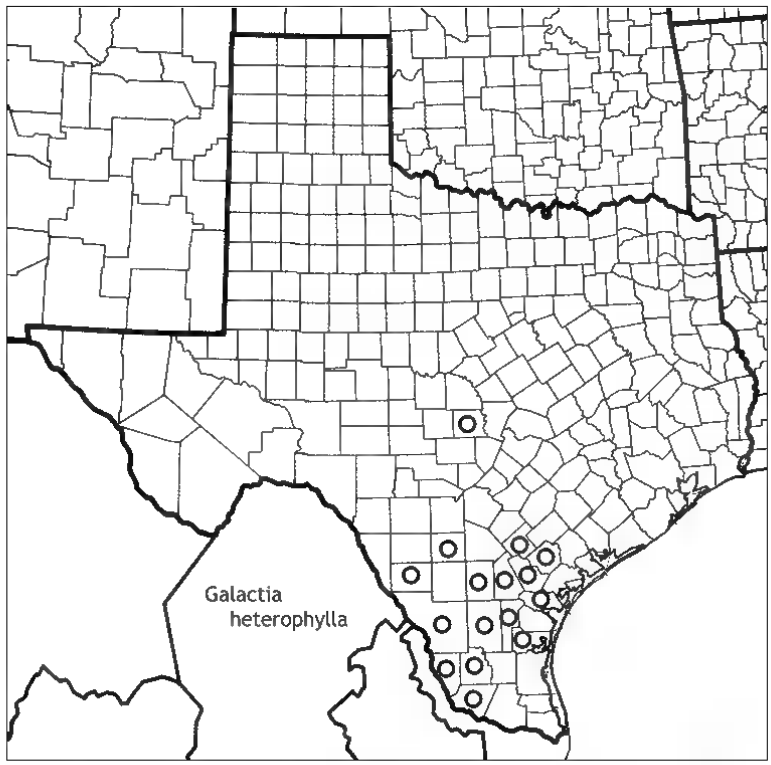
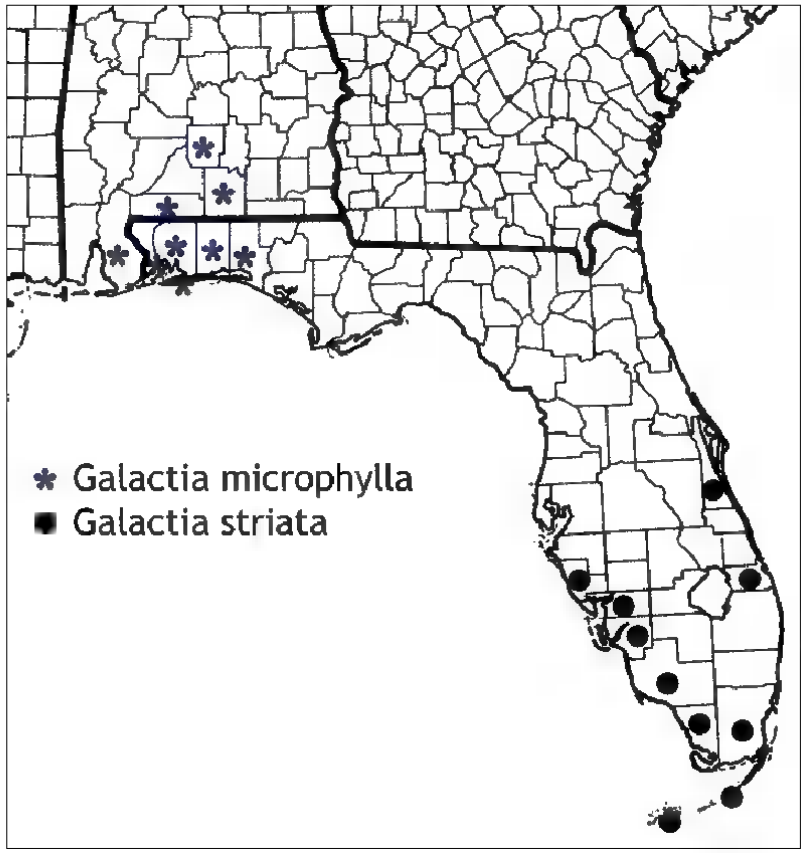
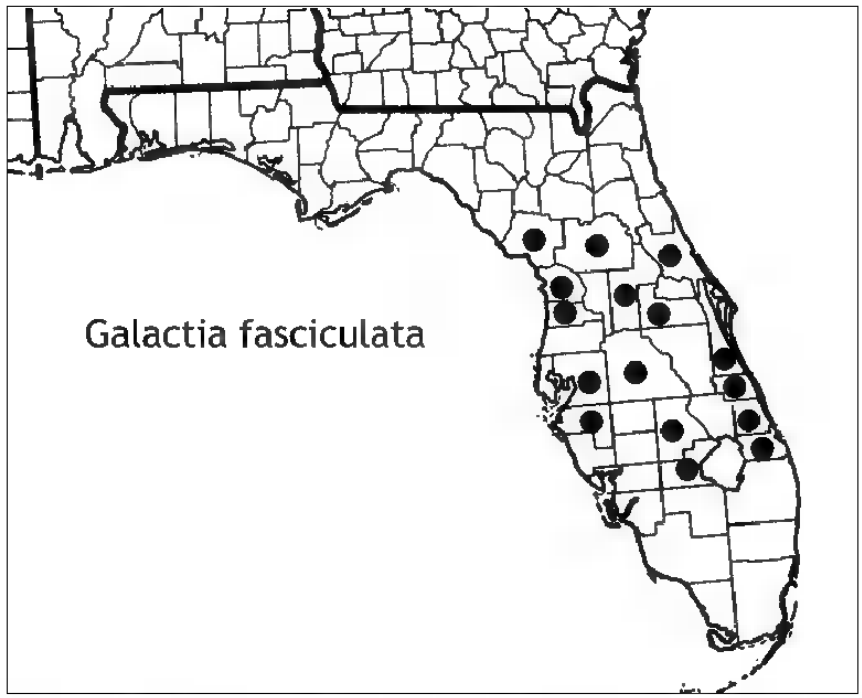

Galactia
heterophylla

Map 4.


Galactia microphylla
Galactia striata

Map 5.



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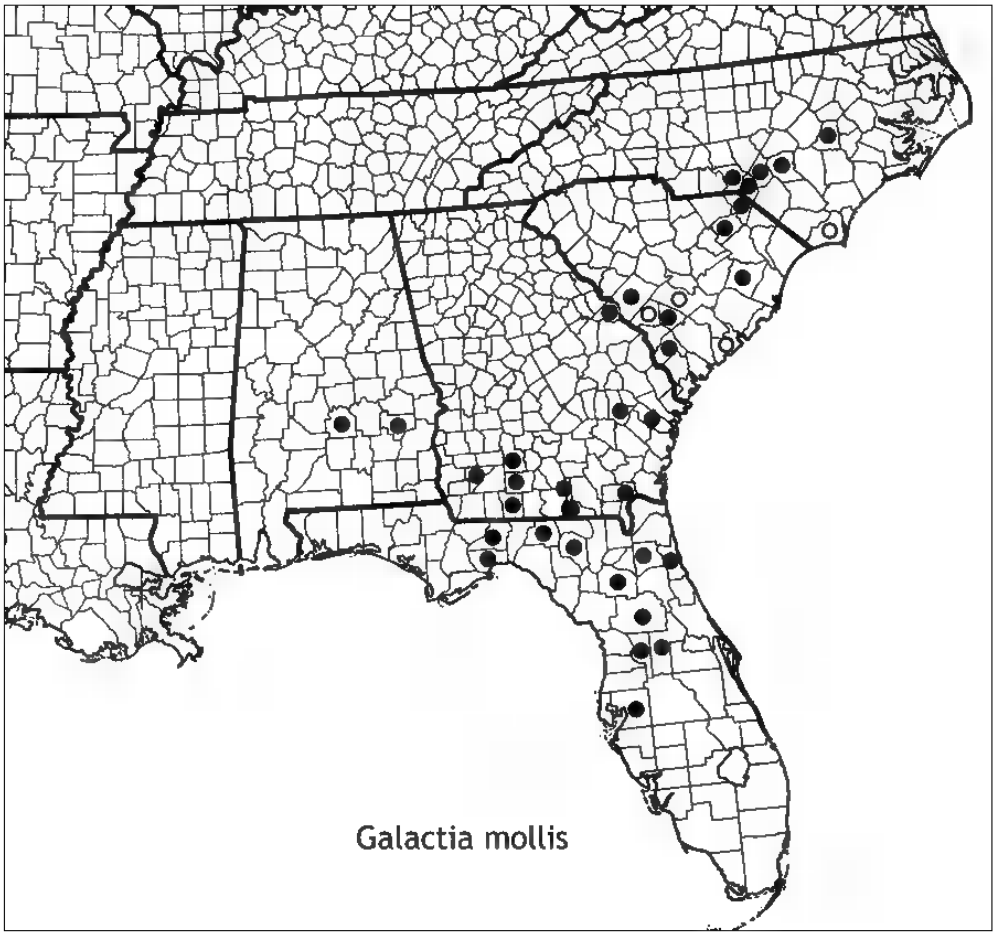

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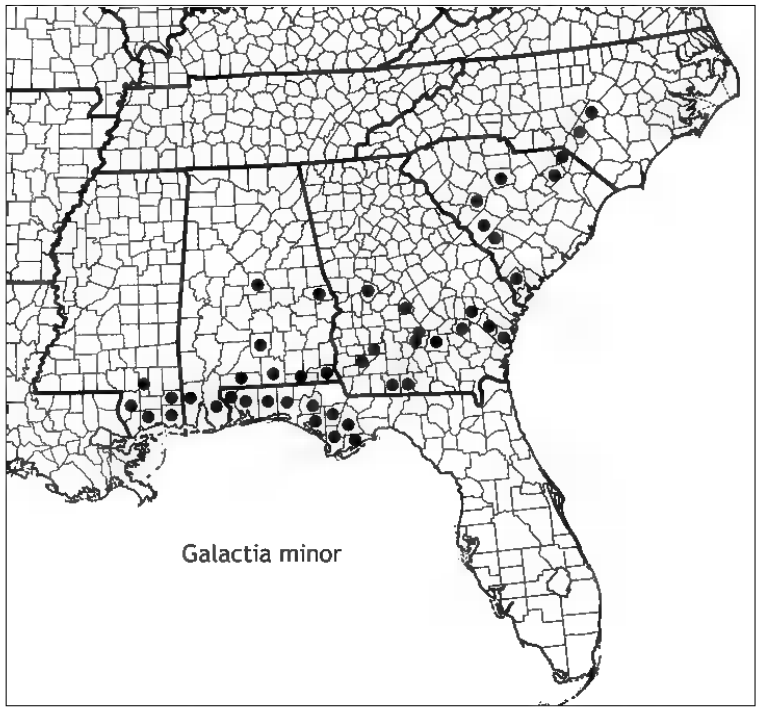
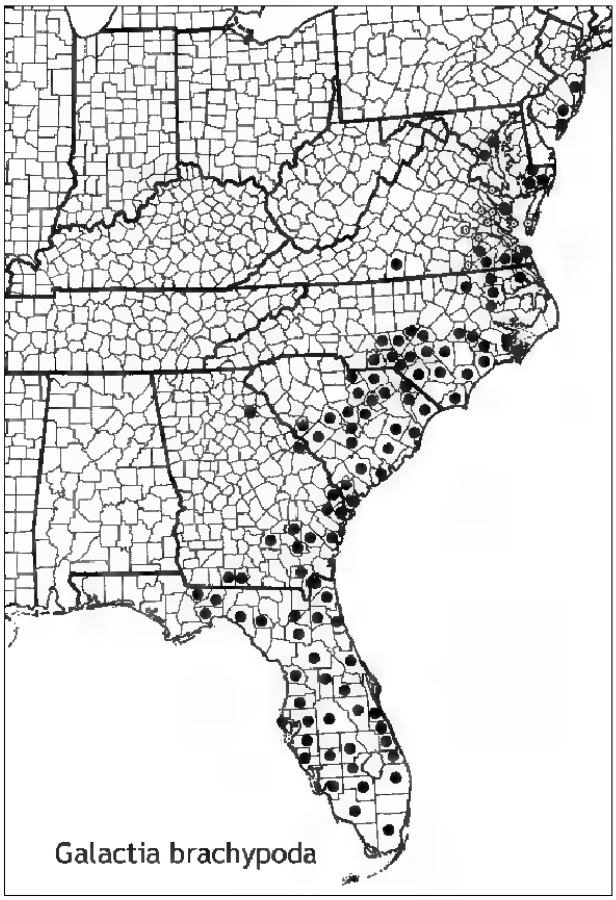
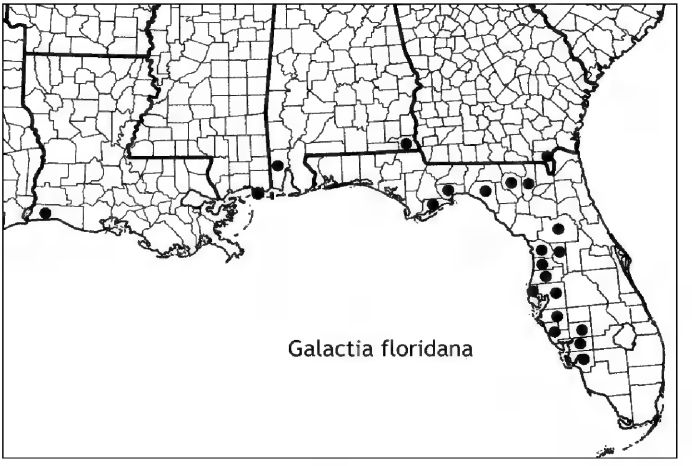
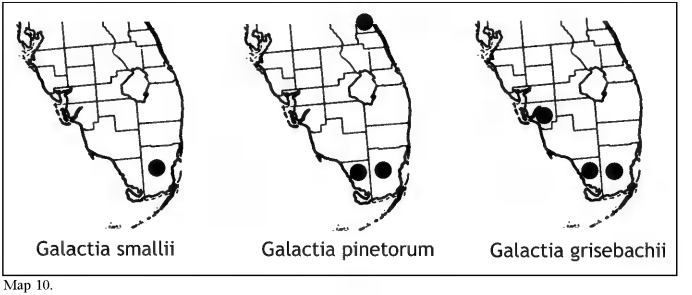


Map 8.

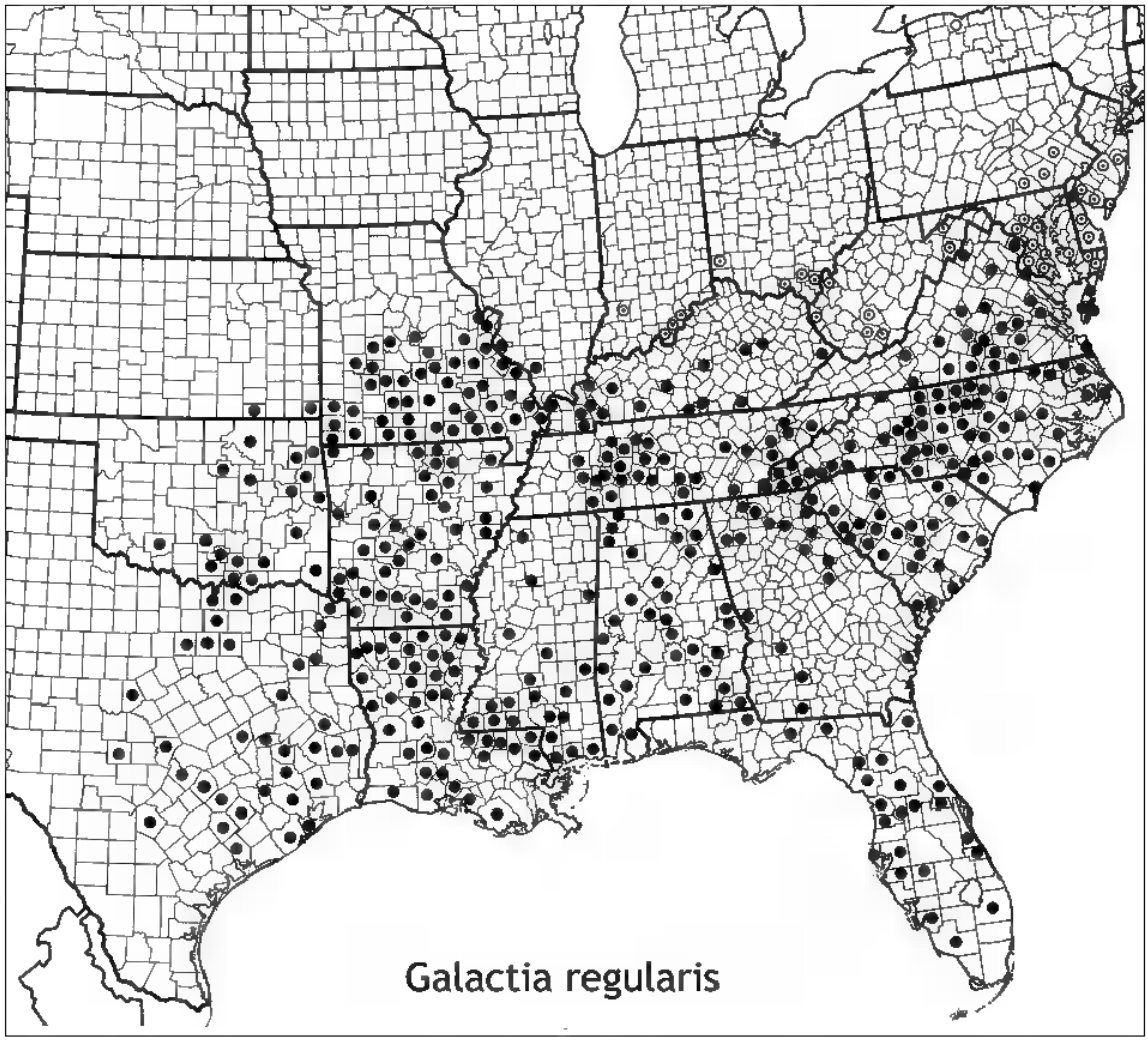



Galactia floridana

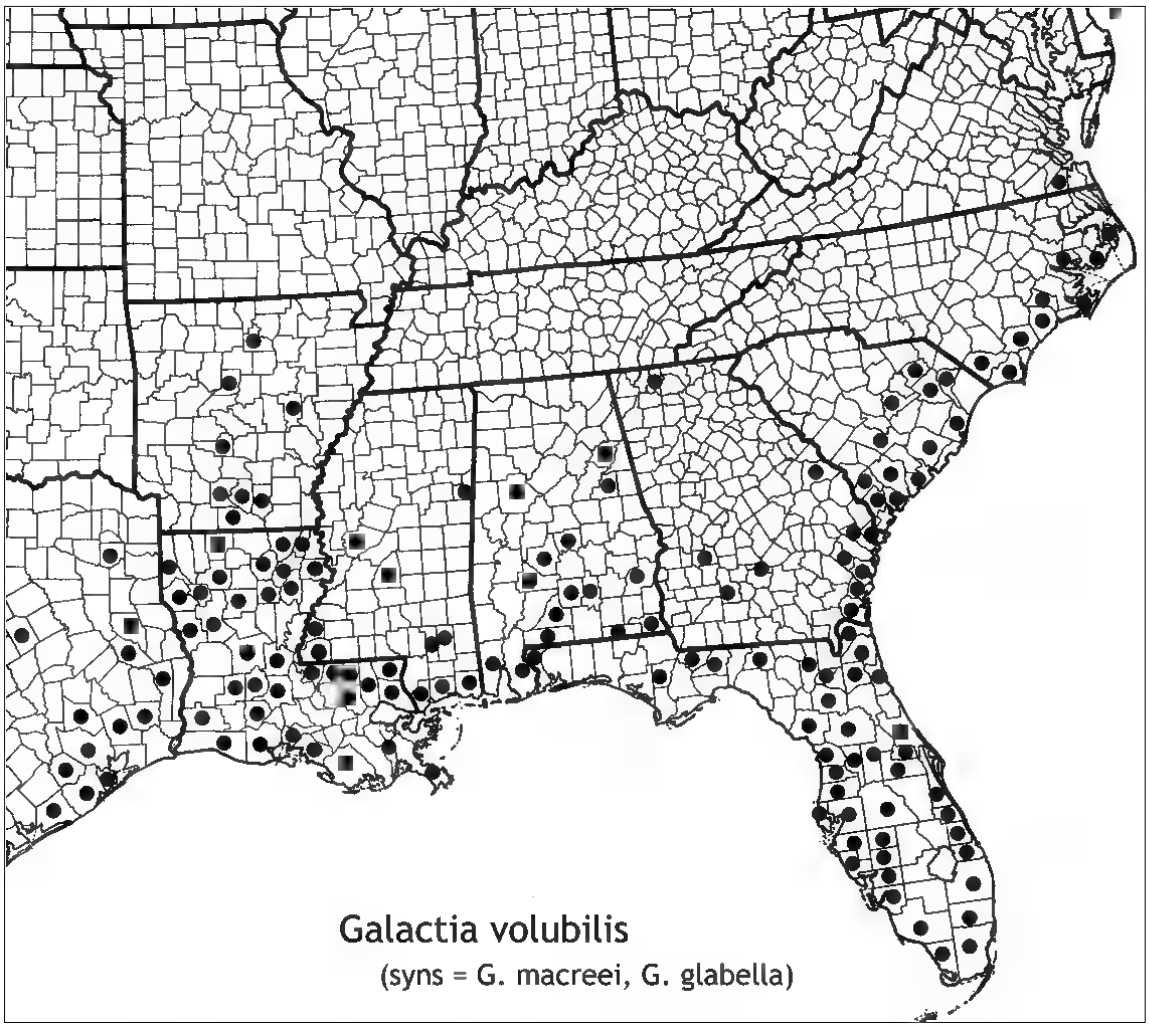
Map 9.


Galactia smallii
Galactia pinetorum
Galactia grisebachii

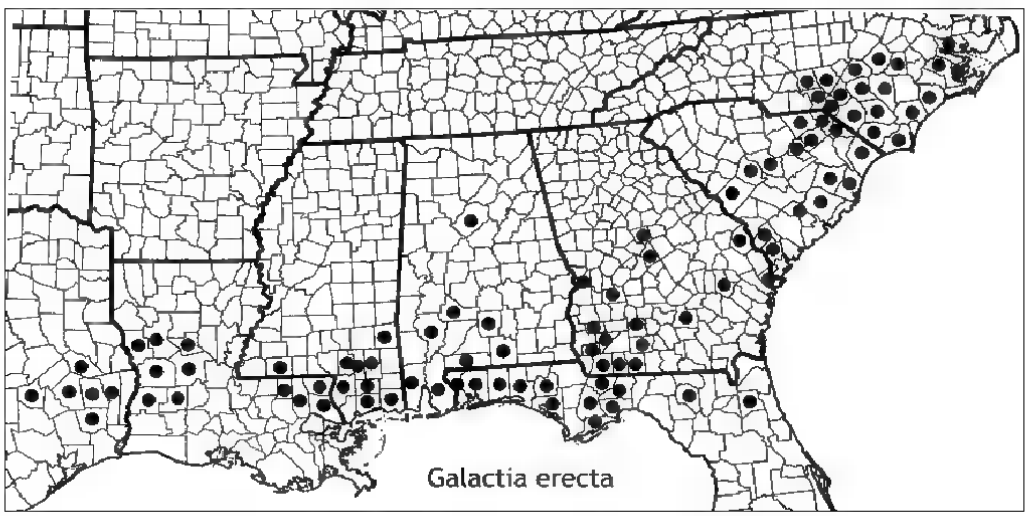
Map 10.



Map 11. Northern records without specimens examined in the present study added from various sources — because there is no other species of *Galactia* in this area, the identifications seem secure.

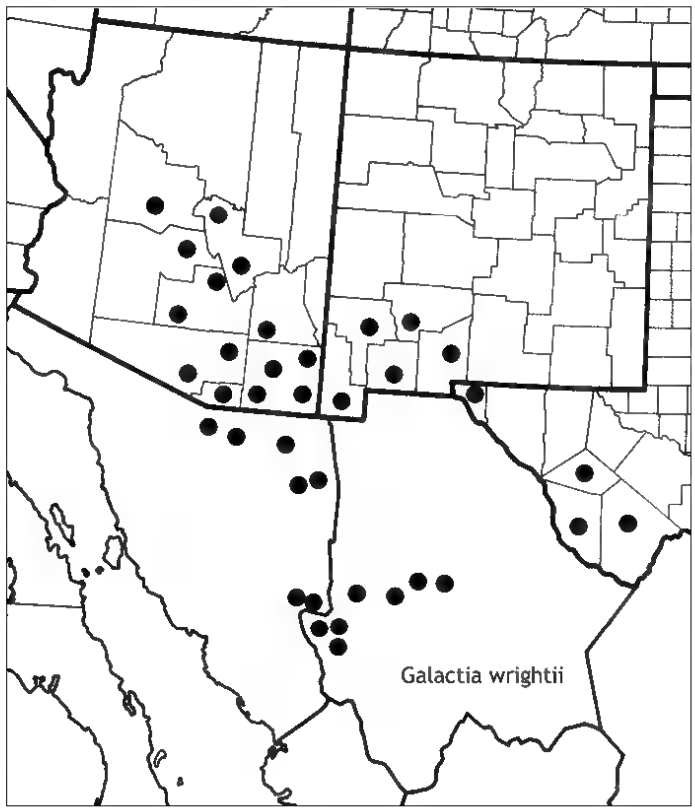

Galactia volubilis
(syns = G. macreei, G. glabella)

Map 12.

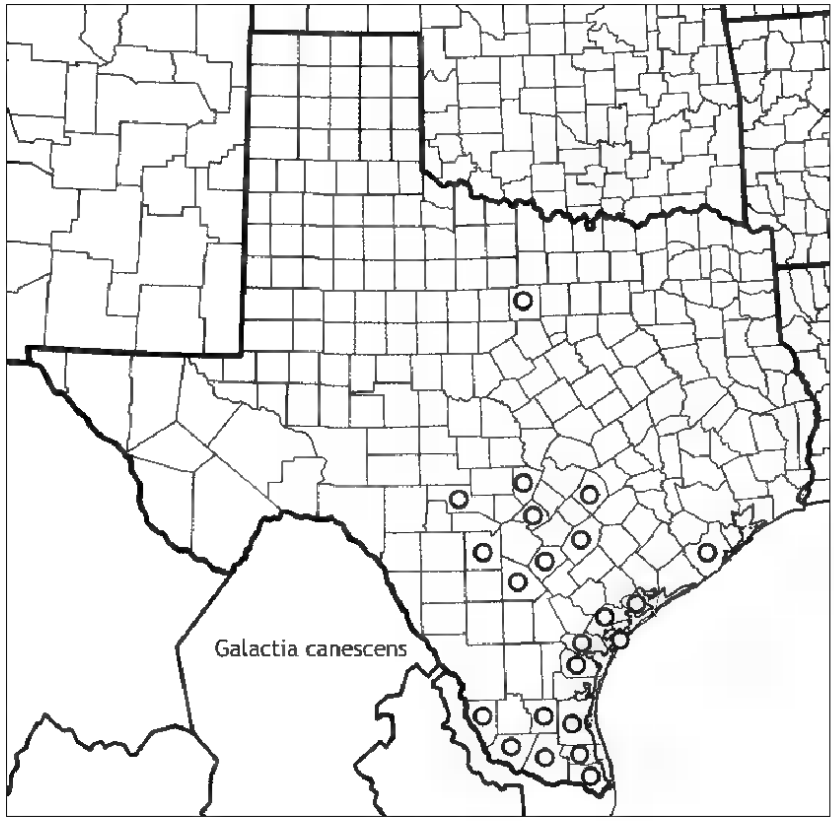

Galactia erecta

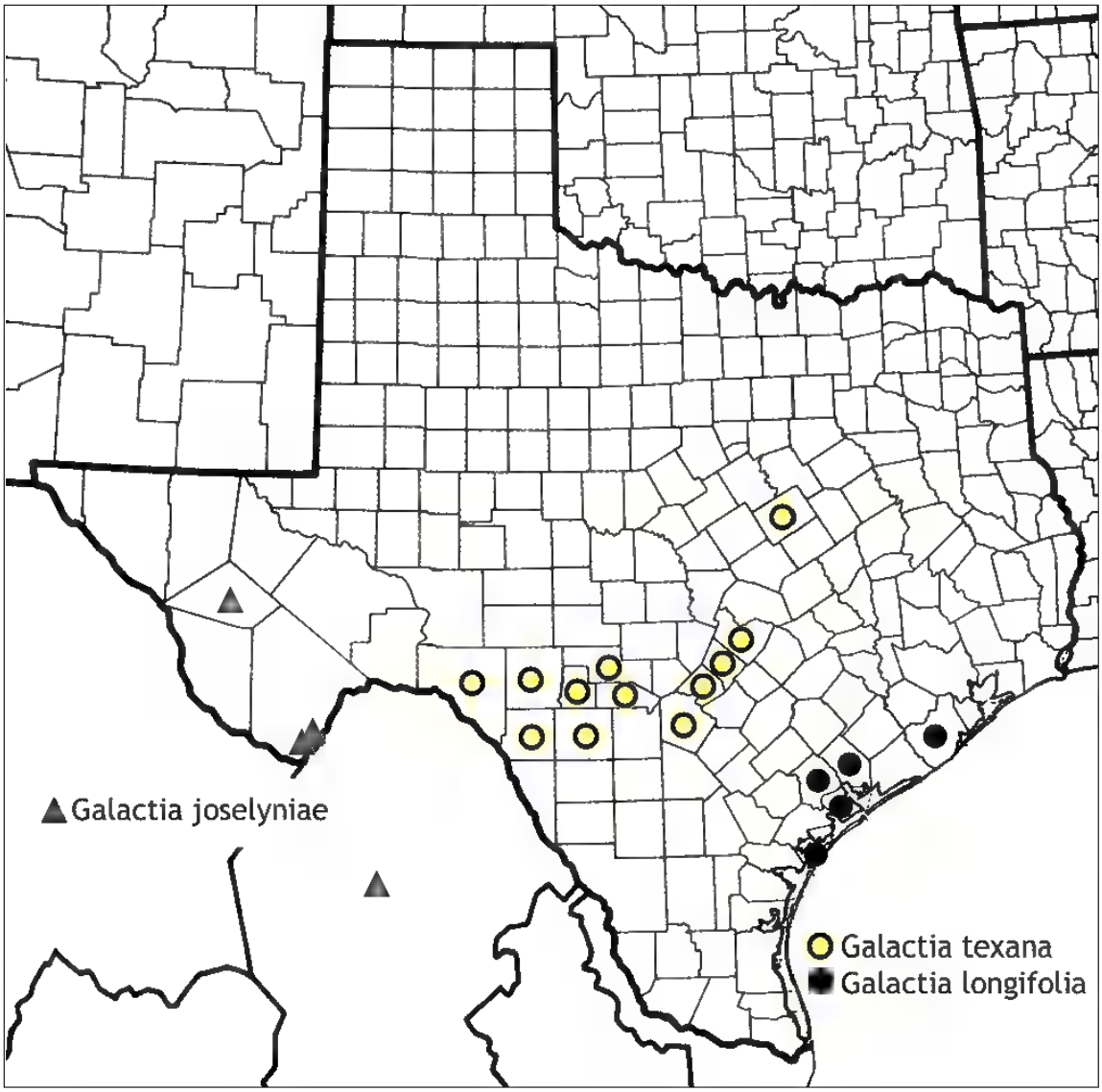
Map 13.

Map 14.



Map 15.




Galactia joselyniae
Galactia texana
Galactia longifolia

Map 16.

Nesom, G.L. 2015. A new species of *Galactia* (Fabaceae) from Central America. Phytoneuron 2015-43: 1–4. Published 15 July 2015. ISSN 2153 733X

A NEW SPECIES OF *GALACTIA* (FABACEAE) FROM CENTRAL AMERICA

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ABSTRACT

Galactia serpentina Nesom, **sp. nov.**, from Honduras has procumbent, non-twining stems and linear-oblong leaflets with glaucous adaxial surfaces. It apparently has no close relative in Central America or Mexico but is most closely similar to *G. pinetorum* Small of southern Florida.

In preparation of the taxonomic treatment of *Galactia* for the Flora of North America North of Mexico, I surveyed collections from Mexico and Central America. A collection from Honduras is distinctive and apparently represents a previously unnamed species.

GALACTIA SERPENTINA Nesom, **sp. nov.** TYPE: **HONDURAS. Dept. Copan**. Ca. 9 air km NNE of Copan, near lumber road on SE-facing slope, igneous soil, with *Pinus oocarpa* and pyrophytic shrubs, mainly melastomes, infrequent trailing perennial, 14 Jun 1977, *J.M. Poole and W.A. Wilson 1073* (holotype: LL!; isotype: LL!).

Similar to *Galactia pinetorum* Small (Florida) in its prostrate habit and linear-oblong leaflets but different in its shorter leaflets with abaxial surfaces glaucous and usually sericeous and shorter rachises and corollas. *Galactia anomala* Lundell (Belize) differs in its twining-climbing habit, solitary, non-pedunculate flowers, and leaflets with attenuate bases.

Stems procumbent, non-twining, not rooting at the nodes, 20–30 inches long, slightly lignescent proximally, sparsely strigose to hirsute-strigose with retrorsely appressed to deflexed hairs. **Leaflets** 3, petiolulate; petioles 8–17 mm; blades linear-oblong, slightly narrowing distally, 20–32 x 2–7 mm, coriaceous, apices obtuse to rounded, margins slightly but distinctly revolute, strigose-sericeous and glaucous abaxially, minutely strigose adaxially with loosely appressed hairs, margins densely strigose adaxially, veins slightly raised on both surfaces. **Rachises** 15–40 mm; flowers 3–6, mostly clustered distally. **Calyces** 4–5 mm, loosely strigose. **Corollas** 8–9 mm, rose-pink, banner striped. **Fruits** apparently densely sericeous, mature size not observed.

Known only from the type collection. Figures 1 and 2.

The species apparently most closely similar to *Galactia serpentina* is *G. pinetorum* Small of southern Florida, which also has linear leaves and procumbent, non-twining stems, but *G. pinetorum* has longer, relatively narrower leaflets with non-glaucous, glabrate to sparsely strigillose abaxial surfaces and longer rachises and larger corollas. *Galactia martii* DC. var. *martii* of Brazil also has linear leaves and a prostrate habit but it differs conspicuously from *G. serpentina* in its flowers tightly clustered at the peduncle apex and pendulous, conduplicately folded leaflets (see Burkart 1971). Other *Galactia* species with linear to narrowly oblong leaflets are twining-climbing in habit — e.g., *G. grisebachii* Urb., *G. isopoda* Urb., *G. jenningsii* Britt., *G. longifolia* (Jacq.) Benth, and *G. volubilis* (L.) Britt. sensu Nesom (2015). *Galactia serpentina* has been identified as the Belize endemic *G. anomala* Lundell (see inset, Fig. 1) but the latter has twining stems, solitary, axillary, sessile flowers, and narrowly oblanceolate leaflets with basally attenuate, essentially sessile blades (a feature seen elsewhere in the genus only in *G. gracillima* Benth. of Brazil, Paraguay, and Uruguay).

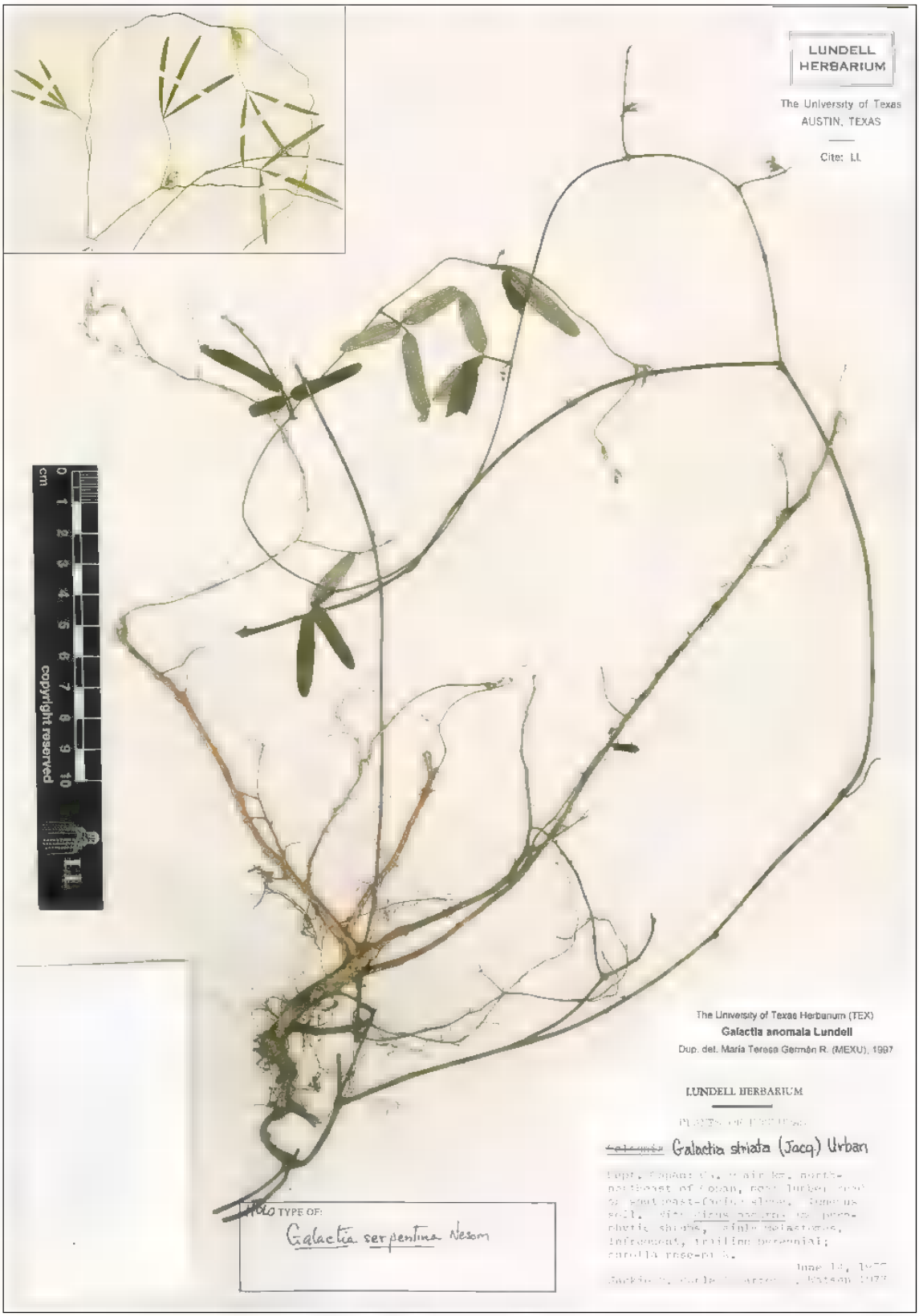

Figure 1. *Galactia serpentina*, holotype. Inset shows portion of *G. anomala* holotype (MICH).

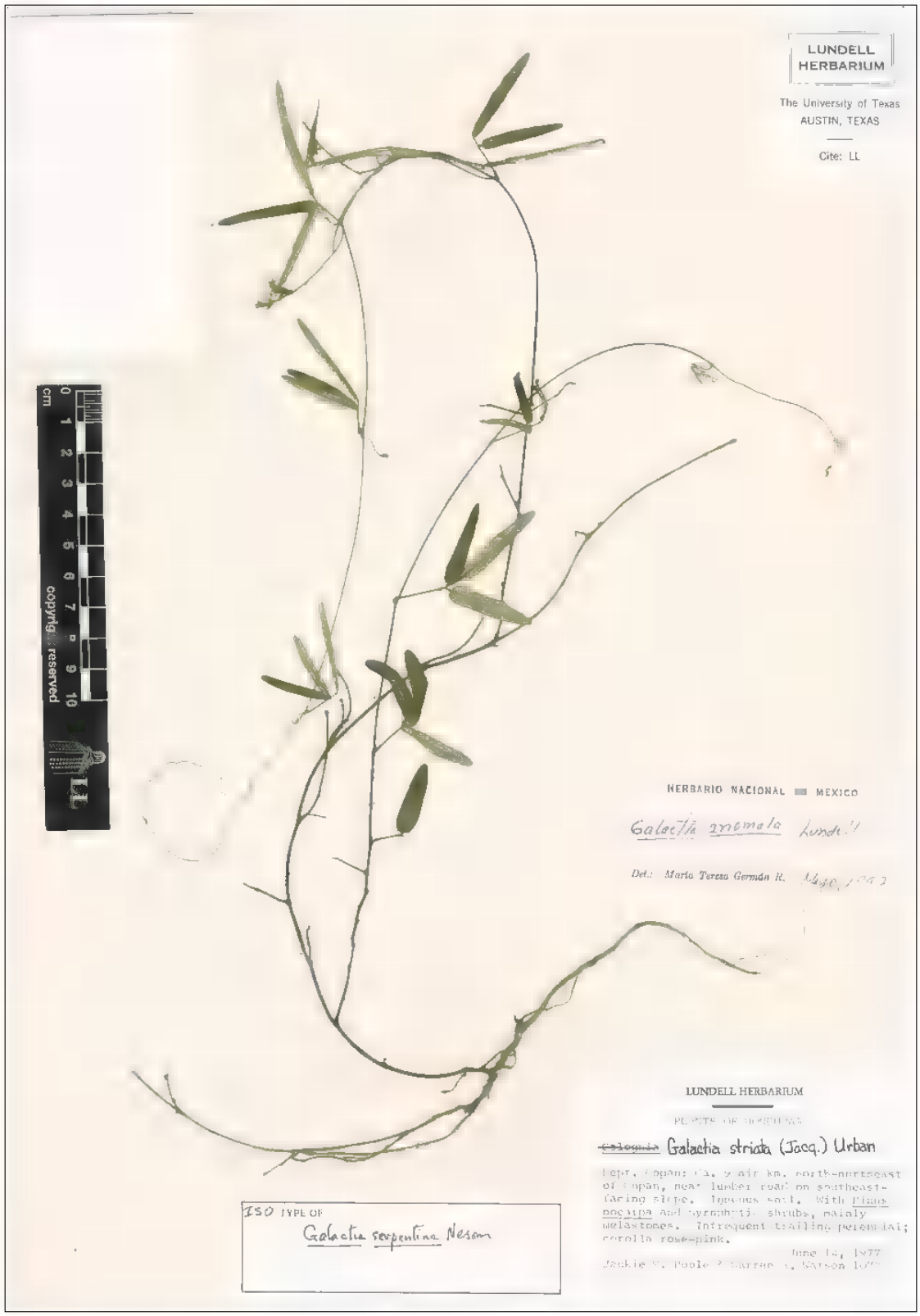

Figure 2. *Galactia serpentina*, isotype.

ACKNOWLEDGEMENTS

I am grateful to the TEX-LL herbarium staff for their help and hospitality during study there, especially to Dr. Tom Wendt, Curator, for providing the photos in Figs. 1 and 2. This study was supported in part by the Flora of North America Association, in conjunction with preparation of the FNA treatment of *Galactia*.

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Sorrie, B.A. 2015. Notes on morphology of *Acmispon helleri* (Fabaceae). Phytoneuron 2015-44. 1–3. Published 15 July 2015. ISSN 2153 733X

NOTES ON MORPHOLOGY OF *ACMISPON HELLERI* (FABACEAE)

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ABSTRACT

Recent field observations of *Acmispon helleri* in North Carolina point out a number of discrepancies or omissions regarding published descriptions, including stem color and pubescence, leaflet morphology and vestiture, and corolla color. Degree of foliation strongly corresponds with phenology — loss of leaves and leaflets over time appears to be common.

Acmispon helleri (Britt.) A.A. Heller is the eastern segregate of the western and midwestern *A. americanus* (Nutt.) Rydb. and is restricted to scattered locations in the piedmont of south-central Virginia, North Carolina, South Carolina, and northeastern Georgia (Weakley 2015). It was formerly placed within *Lotus*, sometimes as a full species, sometimes as a variety (see Brouillet 2008 and Weakley 2015 for synonymy).

Observations of living plants at sites in the lower piedmont of Union County, North Carolina, in 2010 suggest that several morphological characters are at variance with published descriptions. The most detailed description available is that of Wilbur (1963); also very helpful are the illustrations in Chafin (2007). Radford, Ahles, and Bell (1968) followed Wilbur in writing their description.

1. Stem color. Neither Wilbur nor Radford, Ahles, and Bell mention this. In the Union County plants, stems are wholly reddish brown. Branches are green, but often reddish brown basally.

2. Pubescence of stems and branches. Wilbur: stems and branches are "glabrate (especially below) to moderately spreading villous-pubescent." In the Union County plants, stems are sparsely to moderately villous throughout and branches moderately to densely villous. Drawings in Chafin (2007) corroborate this observation.

3. Leaflet morphology. Wilbur: leaflets "slightly mucronulate." Leaflets in Union County plants are mucronate with distinct, sharp, protruding tips.

4. Leaflet vestiture. Wilbur: leaflets "completely glabrous or the margins villous, and surfaces glabrous to sparsely villous." In the Union County plants, both surfaces of leaflets are moderately covered with appressed hairs; the margins are villous.

5. Corolla coloration, wings. Wilbur: "wings yellowish and tinged with pink." In the Union County plants, wings are entirely pale pink, with red venation. Photos of these plants (Fig. 1), and also those in Chafin (2007), corroborate this observation.

6. Corolla coloration, keels. Wilbur: "the keel yellowish." In the Union County plants, keels are dull white with a yellow tip.

7. Legume shape. Published descriptions merely state that pods are "linear" or "narrow," which is partly true, but they are also cylindrical.

Figure 1. *Acmispon helleri*, Union County, North Carolina, July 2010.

In the field, I was struck by how "full" or "robust" plants of *A. helleri* appear. That is, by examining herbarium specimens beforehand, I was expecting to see plants that had relatively few leaves and that would appear slender and sparsely foliated. Living plants (Fig. 1) appear very leafy, whereas specimens, especially those collected later in the season, have lost many leaves or leaflets. Thus, plants in September may have half or one-third as many leaflets as plants at anthesis in early August (pers. observ.). The loss of leaves over time appears to be common in *A. helleri* and may be an adaptation to loss of soil moisture in the clayey, shrink-swell soils in which this species typically grows.

Wilbur's description reflects the fact that available specimens were collected during the middle and later portions of the species' growing season. If specimens from earlier in the season were available, i.e., with most flowers at anthesis and with a full complement of leaves, his description would have been improved.

ACKNOWLEDGEMENTS

I wish to thank the staff of the University of North Carolina Herbarium (NCU) for access to their holdings and to the North Carolina Natural Heritage Program for the opportunity to survey many of the state's rare plants and natural areas.

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ON THE IDENTITY OF *STERCULIA LAXIFLORA* RUSBY (MALVACEAE: STERCULIOIDEAE)

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ABSTRACT

The name *Sterculia laxiflora* Rusby (Malvaceae: Sterculioideae) is based on a mixture of more than one taxon: a several-flowered inflorescence of *Erythropsis pallens* (Wall. ex King) Ridl. (Malvaceae: Sterculioideae) and bark and leaves of *Pachira aquatica* Aubl. (Malvaceae: Bombacoideae). The several-flowered inflorescence that forms part of one of the two syntypes is selected as the lectotype of the name *S. laxiflora*.

Sterculia laxiflora Rusby (Malvaceae: Sterculioideae) was described from material "collected by Miguel Bang in Bolivia, without number, locality or date" (Rusby 1920). As far as can be determined, only three other authors have accepted this name (Foster 1958; Gentry 1976; Villegas Coimbra 1993) and they apparently did so without examining type material or identifying additional specimens that could be assigned to this species. Taylor (1989), who revised the American species of *Sterculia* L., excluded *S. laxiflora* from that genus and considered it to be a species of *Cola* Schott & Endl. (Malvaceae: Sterculioideae). Although she equivocated in her dissertation as to whether or not *S. laxiflora* represented *C. nitida* (Vent.) Schott & Endl. or *C. acuminata* (P. Beauv.) Schott & Endl., she annotated the syntype material as *C. acuminata*.

Two specimens in the herbarium of the New York Botanical Garden comprise the syntype material of *Sterculia laxiflora*. One of the two is sterile and consists of part of a digitately compound leaf and several detached leaflets (NY 00222371!) whereas the other consists of a piece of bark, a digitately compound leaf, and a several-flowered fragment of an inflorescence in a packet (NY 00222372!) (Fig. 1A). Examination of this type material leads us to conclude that the inflorescence and flowers represent *Erythropsis pallens* (Wall. ex King) Ridl. (Malvaceae: Sterculioideae) and that the bark and leaves represent *Pachira aquatica* Aubl. (Malvaceae: Bombacoideae). This is somewhat surprising as otherwise there is no record of the Asian genus *Erythropsis* Lindl. ex Schott & Endl. in cultivation in Bolivia or South America.

The only Neotropical collection of *Erythropsis pallens* that we have found is a specimen gathered in the botanical gardens of Trinidad (*J.W. Hart 3557*, US-2 sheets!) (Fig. 1B). The collection was made in 1889, which establishes that the species was introduced into Trinidad by that year but how much earlier is unknown. The species is not listed in Prestoe's (1870) catalog, unless it is masquerading as "*Sterculia* sp." from the East Indies.

Figure 1. A. Lectotype of *Sterculia laxiflora, Bang s.n.* (NY 00222372 pro parte). B. Fragment of an inflorescence from a specimen of *Erythropsis pallens* cultivated in Trinidad, *J.H. Hart 3557* (US).

It is unclear how Miguel Bang acquired material of *Erythropsis pallens*, if in fact he did. According to Rusby (1893), Bang was trained as a gardener by the Royal Botanic Gardens, Kew, and sent out ca. 1883 to South America to collect living orchids. While his route to Bolivia is unknown, it is possible that it included a stopover in Trinidad to visit the botanical gardens, which also had strong ties to Kew. However, one cannot discount the possibility that the mixture is entirely the fault of Bang's subsequent patron H.H. Rusby, who oversaw the labeling and processing in New York of the herbarium specimens that Bang sent to him from Bolivia. Irrespective of what transpired, the name *Sterculia laxiflora* is based on a mixture and by choosing the several-flowered inflorescence fragment as the lectotype, the Rusby name becomes a synonym of a species in a different genus of Malvaceae albeit in the same subfamily.

ERYTHROPSIS PALLENS (Wall. ex King) Ridl., Bull. Misc. Inform. Kew 1934: 215. 1934. *Sterculia pallens* Wall. ex King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 60: 73. 1891. *Firmiana pallens* (Wall. ex King) Kosterm., Pengum. Balai Besar Penjel. Kehut. Indonesia 54: 16. 1956. **LECTOTYPE** (see comments below): **India.** Uttrakhand: Gurhwal [= Garhwal], s. d. (fl), *H. Falconer 289* (K 000380107 (fls) as image!; isolectotypes: BO, CAL, L, P 06737162 (fls) as image!).

Sterculia laxiflora Rusby, Descr. S. Amer. Pl., 56. 1920. **LECTOTYPE** (designated here): **Bolivia.** S. loc., s. d. (fls), *M. Bang s.n.* (NY 00222372 several-flowered inflorescence only!).

Sterculia pallens Wall. ex Voigt, Hort. Suburb. Calcutt., 105. 1845, nom. nud.

Sterculia wallichii Falc. ex Brandis, Forest Fl. N.W. India, 34. 1874, nom. nud., pro syn.

Sterculia pallens Wall. ex Hochr., Bull. Inst. Bot. Buitenzorg 19: 22. 1904, nom. nud.

The name *Sterculia pallens* Wall. ex King was lectotypified in two stages. First, Ridley (1934: 215) selected *Falconer 289* as "type" from among the original material cited by King (1891: 73), who associated the specimens of *S. fulgens* Wall. ex Mast. from "Tropical Western Himalaya" that were listed by Masters (1874: 360) with his new species. Among these specimens was a collection by Falconer from Garhwal. Kostermans (1956: 19) then narrowed down Ridley's selection by stating that the type of "*Erythropsis pallens* Ridley" was the sheet of *Falconer 289* "conserved in the Kew Herbarium that consists of flower-bearing branches only." In doing this, Kostermans (1956: 19) effectively excluded another sheet (K 000380108 as image!) of the same collection that consists of leaves alone.

Stearn in Blatter and Millard (1954: 79) attempted to make the combination *Firmiana pallens*, but Stearn failed to clearly indicate the basionym and his combination in *Firmiana* is not validly published (McNeill et al. 2012; Art. 41.5). The combination *F. pallens* must be attributed to Kostermans (1956: 16), who cited *Sterculia pallens* in synonymy.

ACKNOWLEDGEMENTS

We thank Barbara Thiers (NY) for lending the syntype material of *Sterculia laxiflora* and for granting permission to publish Figure 1A, an image that belongs to the C.V. Starr Virtual Herbarium (http://sciweb.nybg.org/VirtualHerbarium.asp). We also thank Ingrid Pol-yin Lin (US) for photography of specimens and Rose Gulledge (US) for making the plate.

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Hammel, B.E. 2015. Three new species of *Pentagonia* (Rubiaceae) from southern Central America, one foreseen, two surprising. Phytoneuron 2015-46: 1–13. Published 11 August 2015. ISSN 2153 733X

THREE NEW SPECIES OF *PENTAGONIA* (RUBIACEAE) FROM SOUTHERN CENTRAL AMERICA, ONE FORESEEN, TWO SURPRISING

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ABSTRACT

The species presented as "*Pentagonia* sp. A" in the recently published Vol. VII of *Manual de Plantas de Costa Rica* is here described as **Pentagonia gomez-lauritoi** Hammel, **sp. nov**. Two additional new species, also from Costa Rica, discovered and fully characterized too recently for inclusion in that volume, are described as well. The latter two are surprising not only for their untimely discovery but also for their unusual leaf morphology. Simple, entire leaves are the rule in Rubiaceae, with *Pentagonia* the one genus where species with pinnately lobed leaves have been described. Until now just 2 out of the 10 species known from Costa Rica (4 out of 15 in *Flora Mesoamericana*) had lobed leaves; **Pentagonia gambagam** Hammel & Aguilar, **sp. nov.**, adds a third. The other new species, **Pentagonia osapinnata** Aguilar, N. Zamora, & Hammel, **sp. nov.**, was at the time of its discovery little short of astounding, as it has pinnately compound leaves, which had not been described for the family.

RESUMEN

La especie presentada como "*Pentagonia* sp. A" en el recientemente publicado Vol. VII del *Manual de Plantas de Costa Rica* se describe aquí como *P. gomez-lauritoi*. Se describe dos especies adicionales, también de Costa Rica, descubiertas y caracterizadas tarde para incluirlas en dicho volumen. Estas dos últimas sorprenden, no solo por su reciente descubrimiento, sino también por la morfología inusual de sus hojas. Las hojas simples y enteras son la regla general en Rubiaceae, *Pentagonia* siendo el único género donde se ha descrito especies con hojas pinnadamente lobuladas. Hasta el momento se conocía solo dos especies (de las diez conocidas) con hojas lobuladas en Costa Rica (cuatro de 15 en *Flora Mesoamericana*); *P. gambagam* figura como la tercera. La otra especie nueva, *P. osapinnata*, en el momento de su descubrimiento fue simplemente asombrosa, ya que tiene hojas pinnadamente compuestas, lo cual no se había descrito para la familia.

Pentagonia Benth. has not been revised in 100 years, during which time the number of recognized species has more than tripled; Standley (1914a) described five new species and recognized a total of eleven in his revision (as *Watsonamra*). Including *Nothophlebia costaricensis* Standl., described in the same volume (Standley 1914b) and subsequently transferred to *Pentagonia*, a total of 12 species were known at the time. Including the three described here, approximately 40 species (12 in Costa Rica, 18 in Mesoamerica) are currently recognized and the genus is in dire need of a thorough revision with careful field work (Rova & Andersson 1995; Taylor 2012). The genus is easily recognized vegetatively by virtue of its frequently unbranched, subshrub to arborescent growth form with the leaves clustered towards the stem apex, its large, entire and strongly carinate, interpetiolar stipules, its usually rather large leaf blades (10 up to at least 200 cm long), and especially by the leaf surfaces distinctly and closely striate with fine epidermal fibers. The calyx tube usually has adaxial patches or lines of glands at or below the sinuses of the lobes. See also Rova and Andersson (1995) and Taylor (2002). It is the only genus of Rubiaceae with any species whose normal, mature leaves are pinnately lobed to deeply pinnatifid. In the New World, occasional individuals of some species of *Simira* may have pinnatifid leaves (Taylor 2002) and a few species of *Cruckshanksia* have leaves deeply and digitately 2 or 3 lobed (see Taylor 1996).

Contrary to what has sometimes been suggested elsewhere [cf. notes under *Pentagonia donnell-smithii* (Standl.) Standl. in Taylor 2012; Taylor & Hammel 2014] field work at La Selva research station and throughout Costa Rica demonstrates habit type to be quite constant within species of *Pentagonia* (see also Taylor 2002). Just three [*P. costaricensis* (Standl.) W.C. Burger & C.M. Taylor, *P. nuciformis* Dwyer, and *P. osaensis* C.M. Taylor] of the 12 species now known from Costa Rica are typically much-branched trees up to 18 meters tall. All the others are treelets mostly less than 8 meters tall and usually monopodial. Of these latter, an occasional small plant may be somewhat branched from near the base, but otherwise in my experience any indicated habit outside these norms has been due to incorrect identification to species or a probable label mix-up.

PENTAGONIA GAMBAGAM Hammel & Aguilar, **sp. nov.** **TYPE: COSTA RICA. Puntarenas.** Cantón de Golfito, Corredor Biológico la Gamba, Santuario Gambagam, 8°41' N, 83°11' W, 110 m, 28 Apr 2014 (fl, fr), *B. Hammel, R. Aguilar*, and *I. Pérez 26730* (holotype: CR; isotypes: MO, GB). Figure 1.

Similar to *Pentagonia macrophylla* by its reddish and bracteate inflorescence, its petiolate leaves, and its narrowly funnelform, trumpet-shaped corolla but differing markedly by its lobed leaf blades, more shallowly lobed calyx, and often greenish, totally glabrous corolla. It is also similar to the locally sympatric *P. wendlandii*, which has sessile or subsessile and entire leaves as well as a tubular and densely tomentulose corolla. The new species has leaves that are much more shallowly lobed than those of all other *Pentagonia* species in the region with lobed leaves.

Shrub or small tree 4–8 m, unbranched; stems blackish brown, matte. **Stipules** reddish, 5–9 × 1.5–4.5 cm, ± ovate to deltate, acute to acuminate, coriaceous, abaxially and densely strigulose, adaxially glabrous. **Leaves** simple; petiole reddish green at the very base, to ca. 10 cm; blade 78–96 × 66–74 cm, spatulate to pandurate, basally truncate to more often shallowly cordate, rarely obtuse (often bullate between the basal secondary nerves), ± coriaceous, dull on both surfaces, densely and minutely strigulose on the main nerves abaxially, glabrous adaxially, pinnately lobed (1/3–2/3 the way to the midrib), and with 15–18 principal secondary veins per side (the ones feeding the lobes somewhat thicker than the rest), the lobes 4 or 5(–7) per side, 8–27 × 11–16 cm [the sinus ca. (4–)8–12 cm from the midrib]. **Inflorescences** subsessile, glomerate; **bracts** reddish, to at least 30 × 16 mm, ovate, sparsely strigulose to glabrescent; flowers to at least 20, sessile or with pedicel to ca. 2 mm; hypanthium 5–7 mm, ± funnelform, densely strigulose; **calyx** limb reddish, 15–20 mm, coriaceous, basally and sparsely strigulose, apically glabrous, somewhat irregularly 5-lobed, the lobes imbricate, 5–7 mm, ± ovate to obovate, apically obtuse to rounded, the **glands** in lines 4–5 mm, from ca. mid tube downward; **corolla** green or greenish yellow to cream colored, 35–40[–55] mm, narrowly funnelform, trumpet-shaped, the tube basally 2–4[7] mm wide, apically 4–6[11] mm wide, straight to sometimes slightly curved at the base, internally pilosulose at the insertion of the filaments and pilosulose to strigulose upward to ca. 6 mm, otherwise glabrous inside and out, 5-lobed, the lobes 4–5[5–8] mm, triangular, marginally granulose puberulent except pilosulose at the very tip; stamens with the filament ca. 13 [15] mm, inserted at ca. 10 mm above the base of the tube, apically curved just below the anther (in life), basally pilosulose, the anthers ca. 3 mm, in life held perpendicular to the major portion of the filament and held at the same level or slightly above the stigma; style ca. 23 mm. **Fruits** reddish, 2.5–3.5 cm subglobose to ellipsoid, densely to sparsely strigulose and markedly pustulose-warty. Measurements in square brackets [ ] are from fresh or EtOH preserved material.

Flowering Apr, Jun; fruiting Apr. At edge and in clearings of wet forest, 110 m elev.; Costa Rica (Prov. Puntarenas), Fila Gamba.

Additional material examined. **COSTA RICA. Puntarenas:** Cantón de Golfito, Corredor Biológico la Gamba, Santuario Gambagam, 8°41' N, 83°11' W, 110 m, 2 Jun 2013 (fl), *Aguilar 14395* (photos; see <https://www.flickr.com/search/?q=RA%2314395>).

Etymology. This species is named (by a noun in apposition) for the Santuario Gambagam, its type and only known locality.

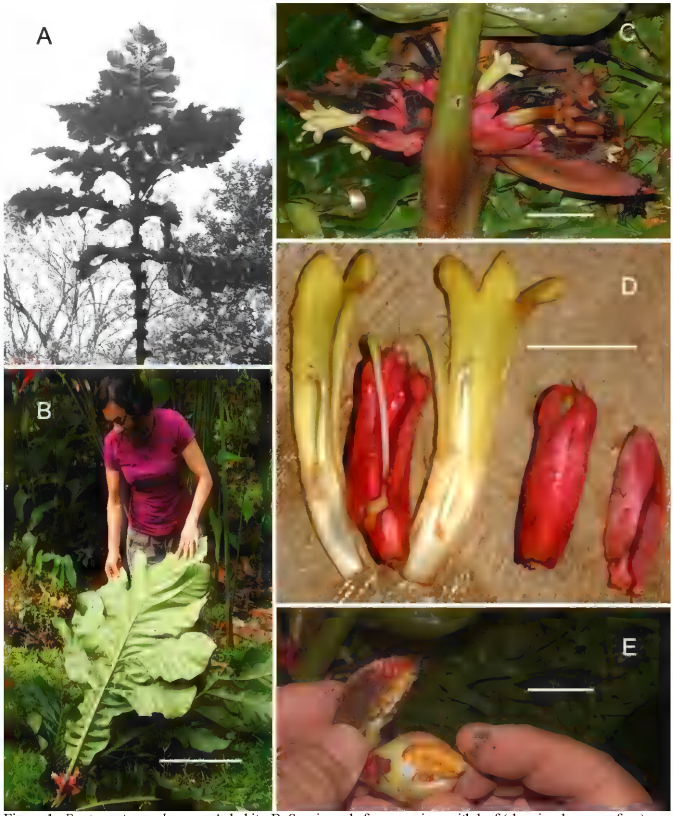

Figure 1. *Pentagonia gambagam.* A. habit. B. Specimen before pressing, with leaf (showing lower surface), stem and inflorescence. C. Inflorescence; D. Flower showing corolla split (on each side of the flower from which removed), flower bud, and associated bract. E. fruit split open. Scale bars: B=20 cm, C=4 cm, D & E=2 cm. All from *Hammel et al. 26730.*

Figure 2. *Pentagonia macrophylla*. Inflorescence from *Hammel et al. 26294* (MO).

Figure 3. *Pentagonia wendlandii*. Inflorescence from *Hammel et al. 26733* (CR).

Figure 4. *Pentagonia lobata*. **Inflorescence from** *Hammel et al. 26114* (CR).

Because of its monopodial habit, large, petiolate leaves, reddish inflorescence with reddish, relatively large bracts, and funnelform, trumpet-shaped flowers, this species on first impression seemed to be an odd version of *Pentagonia macrophylla* Benth. with lobed leaves. However, closer examination prevented us from leaving it lie as that. In any case, the taxonomy we follow here, that of Taylor 1995, 2002, 2012 and Taylor & Hammel 2014) gives considerable weight to lobate vs. entire leaves as an indicator of speciation. Armed with that consideration, we find that the more shallowly lobed calyx (ca. 1/3 vs. 3/4 to completely), the often greenish and externally glabrous (vs. white to cream-colored and densely strigose-tomentulose) corolla along with the lobate leaves clearly distinguish *P. gambagam* from *P. macrophylla*. We should note that while the corolla of *P. macrophylla* flowers has sometimes been described as simply "tubular" (e.g., Taylor 2012), examination of live material and photos of that species demonstrate that it is narrowly funnelform with patent lobes (see Fig. 2), very much as that of *P. gambagam*. The total population we found of *P. gambagam* (ca. ten individuals) occurs only in and at the edges of the clearing surrounding the Gambagam station and its dwellings. Several hours of hiking in forest close-by, revealed only *P. lobata* C.M. Taylor and *P. wendlandii* Hook. as locally sympatric. The latter was also flowering at the time, and was found along streams as well as in the same clearing. We note that the corollas of *P. wendlandii* in this area are cream-colored and more decidedly tubular, with the tube little or not at all expanded towards the apex, and the lobes erect or only slightly spreading (see Fig. 3). In material of *P. wendlandii* from Panama the corollas—usually described on labels simply as yellow—may be externally nearly glabrous to sparsely strigulose or subtomentulose, with the trichomes becoming denser towards the apex, whereas in this population we found them to be densely tomentulose throughout. The flowers of *P. lobata*, on the other hand, have a greenish corolla that is broadly funnelform and glabrous externally, with suberect to ± patent lobes (Fig. 4). The same is true for *P. gymnopoda* (Standl.) Standl. and *P. tinajita* Seem., two other lobate-leaved species from Mesoamerica. The fourth species (*P. pinnatifida* Seem.) with lobed leaves known from the region is

very distinctive for its basally auriculate leaves and flowers with a red corolla. *Pentagonia gambagam* differs from all four of those by its much more shallowly lobed leaves (the sinus no less than 8–12 vs. no more than 4 cm from the midrib). We have also examined material or images and/or protologues of all the other species of *Pentagonia* with lobed leaves and found none a good match to this material.

Due to its highly restricted distribution in disturbed habitat and also because of certain morphological characters, *Pentagonia gambagam* might be speculated to be of hybrid origin, with the two-mentioned sympatric species as parents. It does produce fruits with what appear to be viable seeds. In common *with P. lobata*, *P. gambagam* has lobed leaves (though less-deeply so and with wider lobes) and a greenish, externally glabrous corolla. With *P. wendlandii* it shares the reddish stipules and petiole bases, a relatively short petiole (compared to *P. lobata*), basally bullate leaf blades, reddish inflorescences, and a non-spatulate, 5-lobed calyx (although some of the flowers do appear to have the calyx limb ± deeply split along one of the sinuses). All three species have a monopodial habit. Numerous other species of *Pentagonia* also appear to have highly restricted ranges (see e.g., *P. osapinnata* below).

PENTAGONIA GOMEZ-LAURITOI Hammel, **sp. nov. TYPE: COSTA RICA. Limón.** Cantón de Talamanca, 3 km Oeste de Volio (Uatsi), 09°37.7' N, 82°54' W, 100 m, 6 May 1990 (fl) *J. Gómez-Laurito & G. Vargas 11958* (holotype: CR). Figure 5.

Differing from all other species of *Pentagonia* known to me by its ferrugineous and often matted, fibrillose indument, very large leaves that are glossy on the upper surface, ebracteate inflorescences, and especially by the yellowish claviform trichomes on the exterior of its densely tomentulose corrolla.

Shrub or treelet, 2–6 m, unbranched or rarely with several main branches (from low down); stems brownish to slightly copper-colored, often somewhat pustulose. **Stipules** (3.5–)5–7 cm. **Leaves** sessile or with a petiole 1–4 cm; blades (37–)71–127(–140?) × (19–)28–56 cm, obovate or (more often) oblanceolate, acute to narrowly rounded or auriculate at the base, entire, sparsely to densely ferrugineous fibrillose to soon glabrescent abaxially, glabrous and sometimes described on labels as glossy adaxially with 15–20 secondary veins per side. **Inflorescences** sessile or with a peduncle to ca. 2 cm, subcapitate to congested–cymose, 1–8 cm; **bracts** apparently lacking (but sometimes with abortive inflorescence branches or flowers 3–11 mm that may resemble bracts). Flowers to ca. 25, with a pedicel to ca. 1–8 mm; hypanthium 3--8 mm, ± cylindrical, densely fibrillose and pilosulose; **calyx** limb reddish to red, 12–20 mm, coriaceous, densely fibrillose basally to glabrescent apically (externally), ± regularly 5–lobed, the lobes imbricate, 3–12 mm, elliptic or ligulate, rounded at the apex, the **glands** sparsely clustered in patches starting ca. mid tube; **corolla** white to cream colored or yellow, the tube 27–35 mm, trumpet-shaped, densely tomentulose externally (with claviform trichomes), the lobes (4–)6–8 mm. **Fruits** red, reddish green or brownish red, 2.5–4 × 2–3.5 cm, ellipsoide or ovoid to rarely subglobose.

Flowering Apr–Jun, Nov; fruiting Jan, Mar, May–Aug, Oct, Nov. Moist or wet primary forest, and stream edges, 0–250(–500+) m; Caribbean slope of Costa Rica and Panama.

Additional material examined. **COSTA RICA. Limón**: Cantón de Limón, propiedad de Selva Bananito Lodge, 09°49' N, 83°04' W, 23 Mar 2010 (bud, label says fruits) *Monro et al. 6579* (CR); 50–100 m, 24 Mar 2001 (bud) *Morales 7733* (CR); 12 Apr 2011 (bud) *Sánchez et al. 2296* (CR); R.B. Hitoy Cerere, 09°40' N, 83°01.5' W, 27 Jun 2000 (fl) *Acosta 1888* (CR); 24 Jun 1996 (fl) *Rodríguez & González 3562* (CR); 12 May 1999 (fl) *Rodríguez et al. 4904* (CR); 17 Jun 1997 (fr) *Soto & Rodríguez 45* (CR); Hitoy Cerere, Quebrada Cunabrí, Jul 1984 (fr) *Gómez 24065* (MO); Cantón de Talamanca, P.N. Cahuita, 09°43' N, 82°49' W, 7 May 2009 (bud, fr) *Vargas et al. 3741*

Figure 5. *Pentagonia gomez-lauritoi*. A. Habit (cut stem with leaves and inflorescence). B. SEM micrograph of fibrillose indument (calyx). C. Inflorescence. D. SEM micrograph of clavate trichomes on outside of corolla. Scale bars: A=20 cm, B & D=0.2 mm, C=2 cm. A & C from *Rodriguez & González 3527*, B & D from *Stapf & Toribio 614*.

(CR); R.V.S. Gandoca-Manzanillo, 09°36' N, 82°36.3' W, 5 Oct 2000 (fr) *Acosta et al. 2872* (CR×2); San Miguel, ASACODE, 9°34' N, 82°40' W, 23 Jan 1997 (fr) *González et al. 1744* (CR); hills between headwaters of Quebrada Mata de Limón and upper branches of Quebrada Tigre, Finca Anai,

09°34' N, 82°40' W, 18 Nov 1984 (fr), *Grayum et al. 4475*, (MO); 12 Mar 1999 (bud, fr) *Hammel 21930* (CR×2, MO); catarrata del Río Sand Box, 29 Nov 1978 (fl) *Gómez-Laurito 4261* (USJ); aguas arriba del Río Sand Box, 17 Jul 1982 (fr) *Gómez-Laurito 8779* (CR); 23 Apr 1983 (fl fide label, but specimen has leaves only), *Gómez-Laurito 9321* (CR); Amubri, camino entre Amubri y Soki, 09°30' N, 82°59' W, 30 Jun 1989 (fl) *Herrera 3092* (CR); 4.5 km Fahrkilometer Sudostlich vo Shiroles an der linken Seite des Río Telire, 2 May 1992 (fl), *Döbbeler 5132*, USJ; along Río Sixaola, 0.9 mi SW of Bambu [Bratsi], 5.5 mi SW of Bribrí, 12 Aug 1977 (fr) *Croat 43294* (MO). **PANAMÁ. Bocas del Toro**: Boca de Drago, finca Rosemary, 15 km de STRI., 09°25.5´ N, 82°13.3' W, 22 Apr 2009 (fl), *Stapf & Toribio 614*, (MO, SCZ); Forest above RR stop at Milla 7.5, 26 Jul 1971 (fr), *Croat & Porter 16254* (MO).

Etymology. This species is named in memory of Costa Rican botanist, friend and colleague Jorge Gomez-Laurito (see Hammel et al. 2015), who because of his numerous trips to the Baja Talamanca region, has made more collections of the species than anyone else. Gomez-Laurito made many important collections of plants in many families from out-of-the way sites and unusual habitats throughout Costa Rica.

Pentagonia gomez-lauritoi is distinctive for its sparsely to densely ferrugineous fibrillose but soon glabrescent stems and leaves, sometimes enormous and usually oblanceolate leaf blades that are apparently glossy on the adaxial surface, ebracteate and congested inflorescences, and corollas with the tube densely tomentulose on the outside with unusual yellowish and claviform trichomes. The trichomes on corollas of all other species of *Pentagonia* from Central America are acicular. The calyx limb is notably persistent in fruit, with the lobes about as long as the tube. Because of its sessile to shortly petiolate leaves the material described here has been mistaken for *P. wendlandii*, however it lacks the large [(10–20)–30 mm], reddish inflorescence bracts that help to characterize the latter species. Also, the young leaves and branches, the stipules and the inflorescence are beset with a distinctive reddish brown, often tightly matted, fibrillose indument, not seen in any other species. The indument on vegetative parts of *P. wendlandii* is of whitish to yellowish ± appressed to suberect (not fibrillose) trichomes and those of the corola tube are acicular, not club-shaped. In describing *P. wendlandii* Hooker (1861) considered the position of the glands of the calyx tube significant; basal in his new species, compared to the only other species known at the time *P. macrophylla*, where they are apical on the calyx tube, in patches at the sinus of the lobes. This character has not subsequently been given much attention, and may or may not be of taxonomic significance. Curiously, in all the material of *P. wendlandii* I have examined for this character, the glands are in the same postion as those of *P. macrophylla* (in patches at or just below the sinuses of the lobes), as they are in *P. donnell-smithii* and *P. muciformis*. In the present new species they are clustered in patches at the middle of the tube. In the remaining Costa Rican species I have found glands distributed as follows: *P. costaricensis* (just above middle of tube), *P. hirsuta* Standl. (very sparse, ephemeral, below middle of tube, best or only seen in flower bud), *P. lobata* (in lines ca. middle of tube), *P. tinajita* (in patches or lines about middle of tube, sometimes beginning near sinuses). In no case did I find glands restricted to the very base of the calyx tube as described and illustrated for *P. wendlandii*.

For its (usually) monopodial growth habit, congested inflorescence and lack of inflorescence bracts this new species is comparable to the sympatric *P. donnell-smithii* [with green inflorescence bracts to only ca. 3(–8) mm], which differs—in addition to lacking fibrillose indument of stems, leaves and inflorescences as well as claviform corolla trichomes—by its often much longer petioles [(1.5–)3–15 cm] and by its strigulose pubescence present throughout the plant, present only, if at all, in the inflorescences of the new species. *Pentagonia gomez-lauritoi* can also be compared to the eastern Panamania *P. sanblasensis* C.M. Taylor with congested and ebracteate or minutely bracteate inflorescences. It differs from that species most obviously by its glabrous (vs. conspicuously pilosulose on the lower surface) mature leaves, by virtue of its red (vs. green) and less deeply (1/4 to ca. 1/2 vs. 3/4 to completely) lobed calyx with the lobes rounded instead of acute, by the claviform

(vs. acicular) trichomes external on the corolla, and by its reddish or reddish brown to greenish red (vs yellow) fruits. The new species is distinct from the enigmatic *P. bocataurensis* Dwyer (as per the protologue; no type, nor any other authoritatively identified material, has been located—cf. Taylor & Hammel 2014) at least by virtue of its red fibrillose (vs golden puberulent) calyx with longer lobes (3–12, vs 0.4–0.8 mm) and by its shorter corolla tube (27–35, vs 35–50 mm).

PENTAGONIA OSAPINNATA Aguilar, N. Zamora, & Hammel, **sp. nov.** **TYPE: COSTA RICA. Puntarenas.** Cantón de Osa, Reserva Forestal Golfo Dulce, Bahia Chal, 8°45' N, 83°28' W, 280 m, 11 Apr 2014 (fr), *N. Zamora et al. 6669* (holotype: CR; isotypes: GB, KRIB, MO) Figures 6–8.

Differing from nearly all other species of *Pentagonia* by its pinnately compound leaves with 8–10(–11) leaflets per side, from the otherwise similar *P. tinajita* and the likewise pinnately leaved (but with just ca. 8 leaflets per side) *P. imparipinnata* by its ebracteate inflorescence.

Shrub or small tree 4–6 m, unbranched (rarely branched); stems with pale copper-colored, slightly exfoliating epidermis (in dried material). **Stipules** reddish green, 2.5–5 × 1–3.3 cm, ± ovate, acute to acuminate, coriaceous, glabrous except marginally (and often inconspicuously) cilliate. **Leaves** (odd-)pinnately compound (sometimes distally subpinnatifid with the ultimate 1-3 pairs of leaflets sessile or rarely laminate across the rachis, but the terminal leaflet usually petiolulate); petiole basally reddish green, 10–18(–23) cm; rachis 27–36(–46) cm, the leaflets 8–10(–11) per side, alternate to subopposite, sessile or with petioluoles to 1.5 cm, the blades (6–)8–26 × (1.5–)2–6[–7] cm, elliptic, basally cuneate (often inequilaterally), apically acuminate, membranaceous, dull abaxially, ± lustrous adaxially, glabrous throughout, the venation brochidromous with 6–11 lateral nerves per side (adaxially impressed in fresh material). **Inflorescences** glomerate, apparently ebracteate; flowers to ca. 15, sessile or with pedicel to ca. 3 mm, glabrous throughout (except as indicated); hypanthium ca. 9[14] mm, ± funnelform; **calyx** limb green, 18–22[20–26] mm, 5-lobed, the lobes 10–14 mm, narrowly ovate or elliptic, rounded at the apex, the **glands** in lines starting at or very near the sinuses and reaching nearly to the base of the tube; **corolla** green, 40–55[–70] mm, funnelform, the tube basally ca. 3[7] mm wide, apically 9–12[15–20] mm wide, curved (60–90°) at ca. 1/3 from base of tube, internally pilosulose at the insertion of the filaments and upward for ca. 7[8] mm, 5-lobed, the lobes 3.5–5[5–8] mm, triangular, marginally granulose puberulent; stamens with the filament 14–20[15–25] mm, inserted at ca. 15 mm above the base of the tube, apically curved just below the anther, basally pilosulose, the anthers 2.5–2.8[3–3.7] mm, held perpendicular to the major portion of the filament (and in the opposite direction to the curve of the corolla) and held 7-12 mm above the stigma; style ca. 22[25] mm. **Fruits** copper-colored, 1.5–3 cm subglobose to ellipsoid, glabrous but markedly pustulose-warty. Measurements in square brackets [ ] are from fresh or EtOH preserved material.

Flowering Jun.; fruiting Apr. In deep primary wet forest, on slopes and along ridges, sometimes at edge of small ravines, 200–280 m; Costa Rica (Prov. Puntarenas), Osa Peninsula, Bahía Chal.

Additional specimens examined. **COSTA RICA. Puntarenas**: Cantón de Osa, Reserva Forestal Golfo Dulce, carretera entre Bahía Chal y Los Mogos, bajando hasta cabeceras de Quebrada Taboga, 25 Dec 1991, (st), *Herrera 5009* (CR); 13 Apr 2014; (fr.) *Aguilar 14910;* 27 Apr 2014 (st), *Hammel, Aguilar & Pérez 26720, 26721, 26722* (CR); 18 Jun 2014 (fl), *Aguilar & Poveda 14927* (MO).

Etymology. The epithet is a combined toponym and descriptive: "osa" for the cantón from which it has been collected, and "pinnata" for its pinnate compound leaves.

Figure 6. *Pentagonia osapinnata*. A. habit. B. Infructesence, with insert showing longitudinal section of mature fruit showing seeds. C. Stipule, open flower, bud (conserved in EtOH). D. Close-up of leaflets, with insert of leaf surface. E. Longitudinal cross section of flower (conserved in EtOH). F. Inflorescence with open flower. Scale bars: A=20 cm, B--F= 2 cm. A, B, D from *Zamora et al 6669*; C, E, F from *Aguilar & Poveda 14927*.

This astounding new species was actually first collected from the type and only known locality over 20 years ago by legendary Costa Rican collector Gerardo Herrera. However, being a unicate and sterile, the specimen lay virtually unstudied (tentatively identified as *Pentagonia* cf. *lobata*); unusual morphologies, especially of leaves can easily be passed over as oddities of sucker shoots. In fact in retrospect, the rather small leaves on the Herrera specimen most probably were from a rather young individual, "2 m" tall and with leaf rachises measuring only up to ca. 18 cm. Excuses — for not having explored the area more carefully on the basis of Gerardo's problematic specimen — aside, the recent and serendipitous rediscovery of plants of this species in fertile condition inspired immediate reaction, the first being to cry "A compound-leaved Rubiaceae? Impossible!"

Figure 7. *Pentagonia osapinnata*. Bud leaves of mature plant.

Pentagonia osapinnata differs from nearly all other congeners by its pinnately compound leaves. It is similar to two locally sympatric species, *P. lobata* and *P. tinajita*, with pinnately lobed leaves. Both of these are similar to the new species in their greenish white, funnelform corollas but differ principally for their leaves that are only lobed. In addition, this new species differs from *P. lobata* for its 5-lobed (vs. spathaceous) calyx and from *P. tinajita* for its curved flowers. It differs from both for its apparent lack of inflorescence bracts and especially for its glabrous, pinnate leaves with 8–10(–11) leaflets per side, vs. estrigulose or puberulent to glabrescent, lobed leaves (with 4–6 or 3 or 4 principal lobes per side in *P. lobata* and *P. tinajita*, respectively). It is also clearly distinct from the recently described Colombian species *P. imparipinnata* Cornejo, which has fewer (ca. 8) leaflets per side and large, persistent inflorescence bracts (Cornejo 2014).

While we have not done any microtomic studies of leaf ontogeny of this species, simple microscopic and photographic observation of bud leaves (see Fig. 7) demonstrate that the leaflets of mature leaves of *P. osapinnata* surely must "arise from separate leaflet primordia" (Foster & Gifford 1996; p. 491). While these observations apply to mature leaves, the situation with the leaves of immature plants—as is often the case with compound-leaved species (cf. Foster & Gifford 1996)—is quite the opposite; the leaves of very small plantlets of *P. osapinnata* may be completely entire, those of somewhat larger plants pinnately-lobed, and these with relatively few lateral lobes, much-resembling the mature leaves of *P. tinajita* (see Fig. 8). This latter-mentioned species we presume to be closely related to *P. osapinnata* because of their very similar floral morphology (rather large, funnelform and greenish white flowers) and thus while the occurrence of compound leaves in

Figure 8. *Pentagonia osapinnata*. Mature leaves of juvenile plants.

Rubiaceae disrupts the norm of standard characters for the family, it most certainly has no far-reaching phylogenetic implication, i.e. that *Pentagonia* and therefore Rubiaceae should have close relatives with compound leaves. Even though pinnately divided and now pinnately compound leaves are apparently unique to *Pentagonia* for Rubiaceae, examples of similar cases of species with compound leaves within families of mostly simple-leaved species are not hard to find [eg. various species of *Solanum* (Solanaceae)]. Plants with very deeply pinnatifid leaves, where very little blade tissue follows along the midrib between the lobes (cf. Taylor 2002, 2012) have long been known for *P. gymnopoda*, a poorly distinguished Panamanian species apparently closely related to if not synonymous with *P. tinajita* (see Taylor & Hammel 2014). Detailed phylogenetic and molecular studies will surely confirm the compound leaves of *P. osapinnata* to have evolved by way of relatives with simple, pinnatifid-lobed leaves. With this new compound-leaved species, *Pentagonia* establishes yet another character to the long list of exceptions for the standard Rubiaceae description (Taylor pers. comm.).

One of the new species described here, *Pentagonia gomez-lauritoi*, is already incorporated (as *P.* sp. A.) into the Costa Rican *Manual* key to species (Taylor & Hammel 2014). The other two can easily be added to that key by the following modification (new couplet 4 equals old couplet 2, new 2' equals old 1' and so on)

1. Láminas foliares compuestas, con 8–10(–11) pinna por lado, glabras en todo ..... **P. osapinnata**
1' Láminas foliares simples, a veces pinnada a bipinnadamente lobuladas (con 3–7 lóbulos principales por lado), variadamente pubescentes a glabrescentes.

2. Láminas foliares lobuladas.

3. Láminas foliares someramente lobuladas, el seno no menos de (4–)8–12 cm del nervio medio; brácteas de la infl. rojizas, hasta al menos 30 mm; cáliz rojiza ..... **P. gambagam**
3' Láminas foliares profundamente lobuladas, el seno no más de 1–4 cm del nervio medio; brácteas de la infl. verdes, 8–25 mm; cáliz rosado o (más a menudo) verde.

ACKNOWLEDGEMENTS

Many thanks to Sara Edwards of Kew for providing high-resolution images of type material of *Pentagonia wendlandii*, helping to confirm that it lacks fibrillose indumentum as well as claviform trichomes. Colleague John Pruski kindly helped as hands-on tutor in the use of the SEM at MO. The second author of *Pentagonia osapinnata* thanks the project INBio-KRIBB for support of field work. Thanks also to Museo Nacional colleague Alexander Rodríguez for providing photos of *Pentagonia gomez-lauritoi*.

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TWO SPECIES REDISCOVERED IN ALABAMA AFTER 100 YEARS

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ABSTRACT

Rhynchosia minima has not been documented to occur in Alabama since 1869-70, when two collections were made by Charles Mohr — a large population was rediscovered in 2014 in a power line right-of way along a county road in Lowndes County. *Ageratum conyzoides* has not been documented in Alabama since 1886, when it was collected by Charles Mohr — a population of about 12 plants was discovered in 2014 under a bridge in Geneva County.

Rhynchosia minima (L.) DC. is an herbaceous, vining, perennial species of Fabaceae. It is pantropical in distribution, occurring in Asia, Africa, Australia, and the Americas (USDA, ARS, National Genetic Resources Program 2015). In the USA it is known from Alabama, Arizona, Arkansas, Florida, Georgia, Louisiana, Mississippi, New Mexico, and Texas (BONAP 2014). It is one of five species of *Rhynchosia* that have been documented from Alabama and one of only two twining *Rhynchosia* species in the state — the other is *R. difformis* (Ell.) DC., which differs from *R. minima* by having flowers in short racemes of 2–8 flowers (vs. elongated racemes of 5-15 flowers) and by having the corolla equal to or shorter than the calyx (vs. corolla exceeding calyx) (Woods & Key 2009).

Rhynchosia minima has been listed as "Historical" (not collected within the last 100 years) and "Introduced or Adventive" in Alabama by the Flora of Alabama Committee (Kral et al. 2011). Inclusion of this species in the Alabama flora has been based on two collections made by Charles Mohr. One collection was from Autauga County in July 1869, but the exact location was not recorded. The other collection was from along the West Fowl River in Mobile County in July 1870.

The species was rediscovered in August 2014 in Lowndes County, where the plants were growing in dry sandy soil in full sun under a power line right-of-way. The population was extensive and extended for approximately 100 meters along the power line corridor, not extending into the adjacent hardwood forest. Both flowering and fruiting plants were observed. The area was rural, with no other disturbance of the site other than the power line corridor and adjacent paved county road.

Alabama. Lowndes Co.: Major Ralph Road at the W side of Sullivan Creek, ca. 25 km SW of Hayneville, dry sandy soil in full sun under power line right-of-way, 32.122000° -86.836556°, elev. 206 ft, 29 Aug 2014, *Diamond 25482* (TROY).

Rhynchosia minima is relatively widespread in Florida and Louisiana but infrequent in Mississippi and Georgia (BONAP 2014). The apparent rarity in adjacent states and its long absence from Alabama is likely due to insufficient collecting activity. This species should be looked for in open disturbed habitats on the Coastal Plain.

Ageratum conyzoides L. is an herbaceous perennial (often flowering as annual) species of Asteraceae (Eupatorieae) native to Central and South America (Johnson 1971). It is now pantropical in distribution, occurring in Asia, Africa, Australia, and the Americas, Europe, and Oceania (CABI 2015; USDA, ARS, National Genetic Resources Program 2015). In the USA, it is known from

Alabama, California, Florida, Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Missouri, and North Carolina (BONAP 2014). Within any state it is usually known only by a single county record (BONAP 2014). The apparent rarity of this species may represent repeated, short-lived colonization events.

Ageratum conyzoides is one of two species of *Ageratum* that have been documented from Alabama, the other being *A. houstonianum* Mill. It differs from *A. houstonianum* by having eglandular peduncles and phyllaries that are abruptly tapering to subulate tips with ciliate margins and eglandular faces (Nesom 2006).

Ageratum conyzoides has been listed as "Historical" (not collected within the last 100 years) and "Introduced or Adventive" in Alabama by the Flora of Alabama Committee (Kral et al. 2011). Inclusion of this species in the Alabama flora has been based on a single collection made by Charles Mohr. Mohr's report (1901) listed *A. mexicanum* Sims in synonymy and noted that the species is "escaped from cultivation. Waste and cultivated places near dwellings. Mobile County. Flowers lilac; July to October. Becoming a troublesome weed in the gardens." Johnson (1971) treated Mohr's plant as *Ageratum houstonianum*, placing a dot on the distribution map for Mobile, Alabama. However, in his discussion he noted that the "report of establishment in Alabama is probably based on errors in identification." Johnson did not list any specimens of *A. houstonianum* or *A. conyzoides* that he examined from Alabama.

Most of Mohr's specimens are located at UNA and US. The University of Alabama has a single sheet of *Ageratum* collected by Mohr, and the label bears Mohr's determination as *A. conyzoides*. This identification was confirmed by M. Guzman in 1983. Steve Ginzbarg, UNA Collections Manager, examined the specimen and noted (pers. comm.) that the specimen lacks glandular hairs on the peduncles and phyllaries and keys to *A. conyzoides* in Cronquist (1980), Weakley (2015), and the FNANM treatment for *Ageratum* (Nesom 2006).

Ageratum conyzoides was rediscovered in Geneva County in November 2014. The plants were in dry sandy soil on the north side of the Pea River under the Alabama Hwy 87 bridge. The population consisted of approximately a dozen plants, flowering and fruiting, in a highly disturbed area, not extending into the adjacent hardwood forest.

Alabama. Geneva Co.: Alabama Hwy 87 at the N side of the Pea River, 0.49 km N of the Florida state line, sandy disturbed area under the bridge, 30.997158° -85.997038°, elev. 87 ft, 16 Nov 2014, *Diamond 25669* with P. C. Harris (TROY).

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OROBANCHE ARIZONICA SP. NOV. AND NOMENCLATURAL CHANGES IN *OROBANCHE COOPERI* (OROBANCHACEAE)

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ABSTRACT

The taxonomy of plants that have been identified as *Orobanche cooperi, O. multicaulis,* and *O. dugesii* is reassessed, resulting in recognition of three species: (1) *O. cooperi* A. Gray with three subspecies: subsp. *cooperi*, **Orobanche cooperi** subsp. **palmeri** (Munz) L.T. Collins **comb. et stat. nov.**, and **Orobanche cooperi** subsp. **latiloba** (Munz) L.T. Collins **comb. et stat. nov.** (2) **Orobanche arizonica** L.T. Collins, **sp. nov.** (a segregate from *O. cooperi*), and (3) *O. dugesii* (S. Wats.) Munz, retained with no change in status. *Orobanche multicaulis* is a heterotypic synonym of *O. cooperi* var. *latiloba*.

The genus *Orobanche* traditionally has been divided into four sections, sect. *Orobanche* and sect. *Trionychon* Wallr. in the eastern hemisphere, and sect. *Nothaphyllon* (A. Gray) Heckard (*Myzorrhiza* Phil.) and sect. *Gymnocaulis* Nutt. in the western hemisphere. The four sections are recognized based primarily on floral morphology and to a lesser extent by inflorescence architecture. Some recent authors (Schneeweiss et al. 2004a, b) have preferred to divide the genus into five genera, based on molecular phylogenetic data (in which case, the taxa of sect. *Nothaphyllon* are transferred to *Aphyllon* Mitch.), although, some authors, such as Wicke et al. (2013), have put these taxa in *Myzorrhiza* Phil. in error. However, because the genus in the broad sense appears to be a monophyletic lineage and because combinations in the segregates are lacking for many of the North American taxa, we have continued to treat *Orobanche* broadly in the present research toward a forthcoming account in the *Flora of North America* series.

The North American species of sect. *Nothaphyllon* have been divided informally into two groups referred to as the *Orobanche ludoviciana* Nutt. complex (Collins 1973) and the *O. californica* Cham. & Schltdl. complex (Heckard 1973). Species in the *O. californica* complex have inflorescences that are mostly corymbose, whereas species in the *O. ludoviciana* complex have inflorescences that are elongate and racemose. Within each complex, species may be separated by details of floral morphology, ecology, geographic distribution, and host preference.

The present research builds from that of Collins (1973), which has already resulted in the naming of one new species in the *Orobanche ludoviciana* complex (Collins et al. 2009). While preparing the treatment for the Flora of North America, it became apparent that there were taxonomic issues associated with a cluster of taxa within the *O. ludoviciana* complex closely associated with *O. cooperi* (A. Gray) A. Heller. The similarity of these taxa has made determination of species difficult. Munz's (1930) treatment of this group has proven unsatisfactory for determining species in the *O.*

ludoviciana complex. Collins et al (2009) clarified some of the issues regarding this complex of species, however others remain unresolved. This paper addresses *O. cooperi* and closely allied taxa.

Three binomials are the focus of this paper: *Orobanche cooperi*, *O. multicaulis* Brandeg., and *O. dugesii* (S. Wats.) Munz. Three questions are posed: 1) Is there an undescribed species submerged within this aggregation of taxa? 2) Do these three binomials represent three different species? 3) What is the taxonomic relationship between *O. cooperi* and *O. multicaulis*?

A new species of *Orobanche*

During the process of reassessing the taxonomic status of *Orobanche cooperi*, a set of specimens accumulated that were morphologically and ecologically distinct from the plants now determined as that species. They represent populations of a smaller-flowered *Orobanche* with acute corolla lobes found mostly north of the Mogollon Rim and widely distributed in the four corners region of Arizona, New Mexico, Utah, and Colorado (Figs. 1, 2). Previously, these specimens have been identified as either *O. cooperi* or *O. ludoviciana* or sometimes as *O. multiflora*. Three factors initially brought our attention to these plants. They flower in the summer, whereas *O. cooperi* flowers from late winter to late spring. They occur at higher elevations and latitude than populations of *O. cooperi* from the Sonoran Desert. Finally, they utilize *Gutierrezia* as primary hosts, as contrasted with *O. cooperi*, which utilizes mostly *Ambrosia*. The habitat for these plants is either pinyon-juniper woodland or cold desert-shrub associations of the Colorado Plateau and contiguous areas.

Extensive study of the morphology, ecology, and geographic distribution of these populations reveals that they do not fit into the protologue of *Orobanche cooperi* or other *Orobanche* taxa. The principal characters that set these plants apart from *O. cooperi* are as follows: (1) the corollas are shorter (15–20 vs. 16–32 mm); (2) the narrowly acute corolla lobes lack an apiculate tooth (Fig. 3); (3) glands are absent from the anthers (Fig. 4); (4) they flower in mid-summer (June–August vs. January–May); (5) the host plants are *Gutierrezia* (Asteraceae: Astereae) (vs. mostly *Ambrosia*; Asteraceae: Heliantheae) (Table 1); and (6) their distribution is mostly north of the Mogollon Rim (above 1500 m), whereas *O. cooperi* is south of the Mogollon Rim and at lower elevations (Fig. 5). Ecologically these aberrant plants are found in the red sands of the high deserts and pinyon-juniper woodlands of the Colorado Plateau. The larger-flowered *O. cooperi* has not been reported above 1000 m. Collins (1973) noted these factors but did not suggest a nomenclatural solution. R.H. Peebles, who collected the type specimen of this segregate taxon, recognized as early as 1935 that it was different from *O. cooperi*. He annotated the holotype with a note suggesting that the specimen was not typical of *O. cooperi* but might be of hybrid origin. The new segregate is formally described as *O. arizonica* later in this paper.

Reexamining *Orobanche dugesii*

In a limited study for a regional flora in Mexico, Rzedowski (1998), following Collins (1973), indicated that *Orobanche multicaulis* should be reduced to synonymy under *O. dugesii,* based on nomenclatural priority. The question posed here is whether *O. multicaulis* and *O. dugesii* are in fact conspecific. More specifically, the question addresses the relationship between *O. dugesii* and *O. multicaulis* var. *palmeri* Munz, as these two are geographically contiguous (Fig. 5) and some confusion exists as to their circumscription. Apparently, her study included the type specimens of *O. dugesii* and *O. multicaulis* var. *palmeri* but did not include the types for *O. multicaulis* var. *multicaulis* or *O. cooperi* (see discussion below). Although Collins (1973) suggested that the two taxa are conspecific, reducing *O. dugesii* to a subspecies of *O. multicaulis*, his combination was never formally published and are questioned herein. This has led to ambiguity as to the taxonomic status of the two binomials and the associated nomenclature.

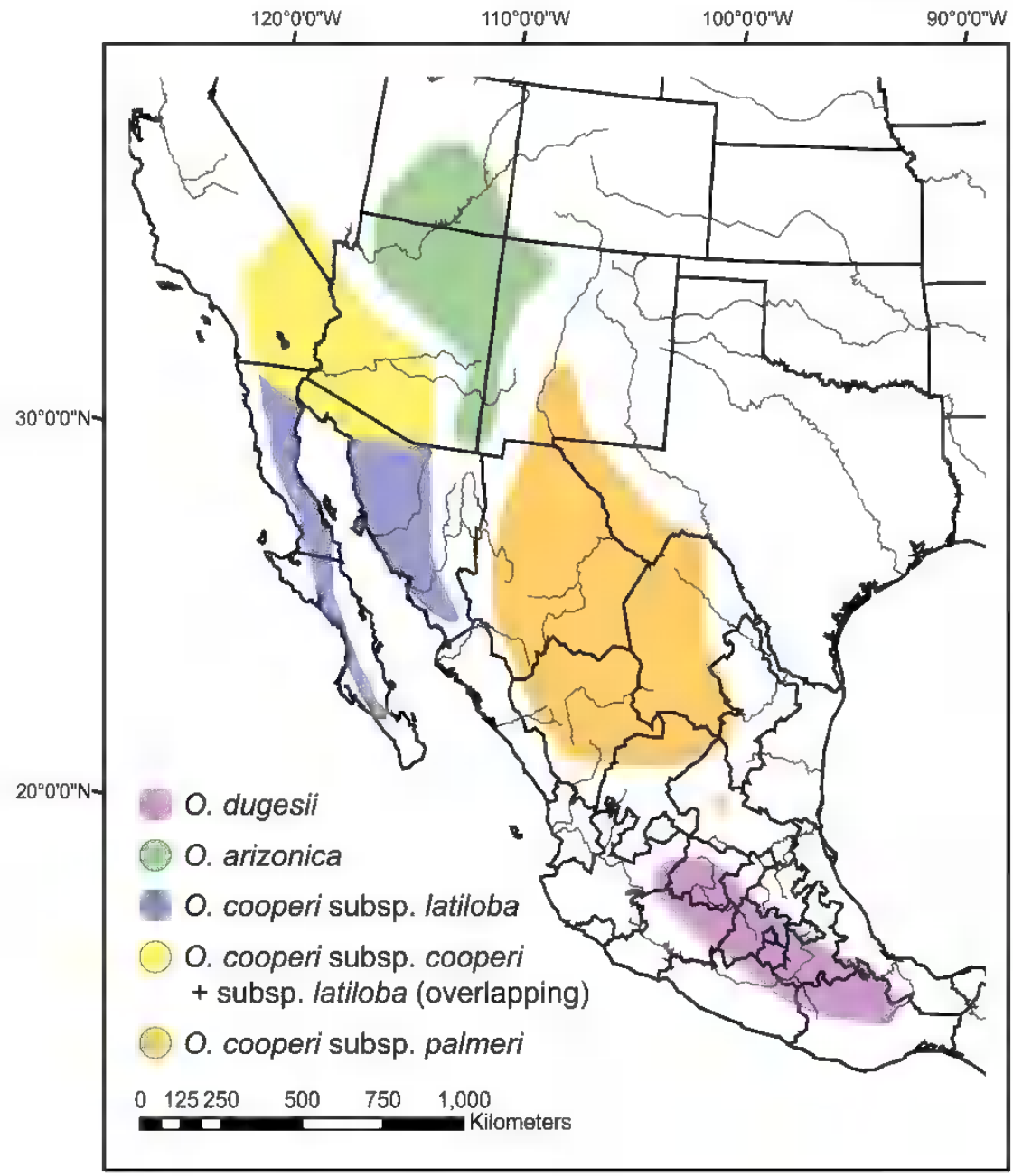

Figure 1. Distribution of taxa in the *Orobanche cooperi* complex, based on representative herbarium specimens examined in the present study.

Figure 2. Habit photograph of *Orobanche arizonica*. Voucher: *Collins 1538* (UWM), collected in San Juan County, Utah. Photo: L. T. Collins.

Figure 3. Habit photograph of *Orobanche cooperi* subsp. *latiloba*. Voucher: *Yatskievych 81-118* (ARIZ, MO), collected in La Paz County, Arizona. Photo: G. Yatskievych.

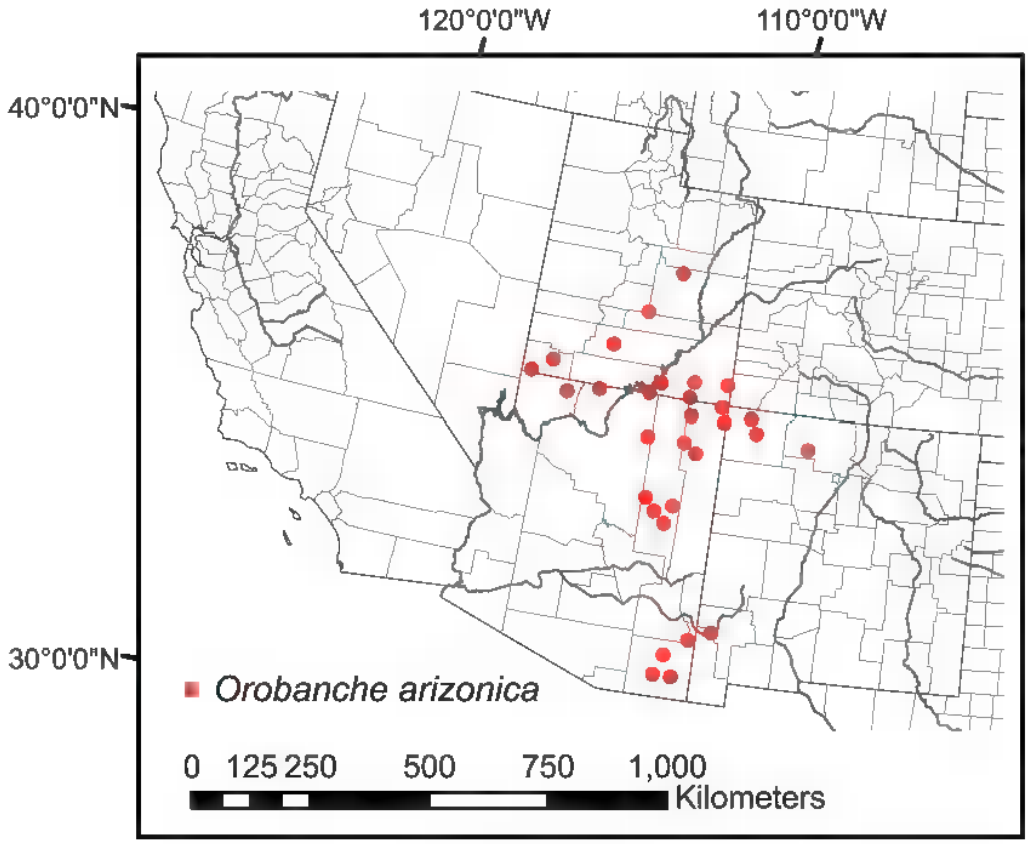

Figure 4. Distribution of *Orobanche arizonica*, based on representative herbarium specimens examined in the present study.

For the present study, a detailed comparison was done of the type specimens for all taxa under consideration, as well as a broader comparison of herbarium material throughout the known ranges of the taxa. We examined 30 herbarium sheets for *Orobanche multicaulis* var. *palmeri*, but only seven sheets for *O. dugesii*. Based on the morphology of the types of *O. dugesii* and *O. multicaulis*, they are indeed distinct taxa (Table 2). *Orobanche dugesii* presents as a much smaller plant (Fig. 6) and lacks the dark purple coloring of *O. multicaulis*. The holotype of *O. dugesii* is essentially glabrous, which is unusual in the group, (a fact noted by Munz [1930]), whereas the holotype of *O. multicaulis* is densely glandular-pubescent (also noted by Munz), which is typical of most *Orobanche* species. The anthers of *Orobanche multicaulis* are usually pubescent and have stalked glands on the dorsal surface (Fig. 3B), characters that are absent from *O. dugesii*. Rzedowski (1998) attributed both conditions of the anthers to *O. dugesii*. Additionally, the palatal folds of *O. dugesii* are glabrous, but those of *O. multicaulis* are densely pubescent. These characters appear to be of critical value in distinguishing the two taxa morphologically. The corollas of *O. dugesii* are short with obtuse or truncate lobes, sometimes bearing a minute apiculate tooth, and are mostly glabrous. Comparatively, specimens assigned to *O. multicaulis var. palmeri* have longer corollas with a more pronounced apical tooth on the lobes and copious indument. The relative paucity of specimens makes it impossible at this time to establish the geographic distribution of *O. dugesii* accurately in relation to *O. multicaulis* var. *palmeri*. However, the two appear to be allopatric in Mexico (Fig. 5). Host data for *O. dugesii* are not available (or questionable, e.g., grass) for most specimens examined, thus preventing any comparison of this aspect of the ecology of the two taxa. Therefore, the plants

heretofore identified as *O. multicaulis* var. *palmeri* are recognized as a taxonomic entity distinct from *O. dugesii*. Accordingly, *O. dugesii* is retained as a separate species distributed principally in the Central Mexican Trans-Volcanic Belt (Clausen 1959). *Orobanche multicaulis* is treated further in the following section.

Figure 5. Dissected corolla of *Orobanche arizonica*, taken from *Holmgren & Holmgren 7066* (NY); note the acute, but not apiculate lobes that are ciliate and pubescent with nonglandular trichomes.

Figure 6. Representative anthers of *Orobanche arizonica* and *O. cooperi*, from herbarium specimens. A. *O. arizonica*, taken from *Holmgren & Hansen 3423* (NY); note glabrous anthers. B. *O. cooperi* subsp. *latiloba*, taken from *Shreve 10163* (ARIZ); note minute spherical glands.

CHARACTER	*O. ARIZONICA*	*O. DUGESII*	*O. COOPERI*
CALYX	8–12 mm	7–9 mm	7–12 mm
COROLLA	15–20 mm, Tube narrow, Pubescent	12–15(–17) mm, tube slightly expanded, Glabrous or glabrate	(12–)15–32 mm, tube slightly expanded, Pubescent
LIPS/LOBES	3–5 mm, erect	3 mm, erect	5–10 mm, reflexed, erect or revolute
COLOR	Purple tinted, corolla lobes purple, tube white	Yellowish with rose tint, thin membraneous	Dark purple, corolla dark purple w/white throat
UPPER LOBES	Triangular acute, not apiculate	truncate, minute apiculate tooth	Triangular acute, distinct *apiculate tooth
PALATAL FOLDS	Pubescent	Glabrous	Pubescent
PUBESCENCE	Glandular pubescent	Glabrous or nearly so	Glandular pubescent
FLOWERING	June–August	May–June	December–April
HOST	*Gutierrrezia*	Unreported, possibly Asteraceae	*Ambrosia, Sidneya, Encelia*
DISTRIBUTION	Colorado Plateau, Southern Great Basin Desert	Trans-Mexican Volcanic Belt	Sonoran Desert , Chihuahuan Desert

Table 1. Comparative characters for three species of *Orobanche*. *Sometimes absent in *O. cooperi* subsp. *cooperi*.

CHARACTER	*O. DUGESII*	*O. COOPERI* SUBSP. *PALMERI*
CALYX	7–9 mm	8–12 mm
COROLLA	12–15 (17) mm,	15--18 mm,
LIPS/LOBES	3 mm, erect	4–6 mm, reflexed or revolute
COLOR	Yellowish, corolla with rose or purple tint, thin membranous	Dark purple, corolla dark purple w/white throat
UPPER LOBES	Truncate or round, minute apiculate tooth	Triangular acute, apiculate tip
PALATAL FOLDS	Glabrous	Pubescent
STAMEN	Anthers glabrous, No dorsal glands	Anthers pubescent, dorsal glands
PUBESCENCE	Glabrous or nearly so	Glandular pubescent
FLOWERING	May–June, date absent on most specimens	December–April
HOST	Unreported, possibly Asteraceae	*Sidneya*

Table 2. Comparative characters of *Orobanche dugesii* and *Orobanche cooperi,* subsp. *palmeri*.

Relationships of *Orobanche multicaulis*

The question of the relationship of *Orobanche cooperi* to *O. multicaulis* must be resolved in order to clarify species circumscriptions in the *O. ludoviciana* complex. Questions have existed for some time regarding the morphological distinction between these two taxa. Although Felger (2000) placed *O. multicaulis* in synonymy with *O. cooperi*, most treatments have maintained the two binomials as separate species. It is well known among field botanists familiar with the Sonoran Desert flora that these two taxa share many morphological characters and ecological requirements and are difficult to distinguish. Both are largely confined to the Sonoran Desert (except *O. multicaulis* subsp. *palmeri* Munz) and utilize the following perennial hosts (all in the Asteraceae tribe Heliantheae): *Ambrosia dumosa* (A. Gray) W.W. Payne, *A. deltoidea* (Torr.) W.W. Payne, *A. salsola* (Torr. & A. Gray) Strother & B.G. Baldwin, as well as *Encelia farinosa* A. Gray ex Torr., and *Sidneya* (*Viguiera sensu lato*). Other hosts are occasionally reported but require confirmation.

The two species were treated by Collins (1973) in a manner that made it appear that *Orobanche cooperi* occurred only in Arizona and California and *O. multicaulis* only in Sonora and Baja, Mexico. The implication was that the two species were somehow restricted at the border between Mexico and the United States. There are no geographical or ecological barriers to produce such a distribution. The lack of data to support this peculiar distribution required a thorough reexamination of the two taxa for the preparation of the treatment for *Flora of North America*.

The original description of *Orobanche cooperi* was published by Gray (1885) under the binomial *Aphyllon cooperi*. Later, Heller (1898) transferred it to the genus *Orobanche*. Beck (1930) and Munz (1930) treated it as a variety of *O. ludoviciana*. Munz further recognized four varieties under the name *O. ludoviciana*: var. *"genuina"* (var. *ludoviciana*), var. *cooperi* (A. Gray) Beck, var. *latiloba* Munz, and var. *valida* (Jeps.) Munz. Shreve and Wiggins (1964) and Felger (2000) treated *O. cooperi* as a species but did not recognize varieties, placing *O. ludoviciana* var. *latiloba* in synonomy under *O. cooperi*. Many current botanists continue to treat these taxa as *O. ludoviciana* var. *cooperi* and var. *latiloba* following Munz (Kearney & Peebles 1960). However, the nomenclature for these infraspecific taxa as varieties or subspecies of *O. cooperi* has not been validly published. *Orobanche valida* Jeps. was established as a California endemic by Heckard and Collins (1982). *Orobanche ludoviciana* is now recognized as a prairie and glade species occurring mainly in the Great Plains of North America and some adjacent areas. Collins *et al*. (2009) presented a summary of the morphological characters of *O. cooperi* and *O. ludoviciana*, as well as their segregate, *O. riparia* L.T. Collins.

The original description for *Orobanche multicaulis* was published by Brandegee (1916). Later, Munz (1930) recognized two varieties, var. *"genuina"* (= var. *multicaulis*) in the Sonoran Desert and var. *palmeri* Munz in the Chihuahuan Desert. Collins (1971) treated var. *palmeri* in Texas as *O. cooperi*. There has since been no change in its taxonomic status. Although Munz (1930) recognized *O. multicaulis* and *O. cooperi* as separate entities, he cited only three specimens of *O. multicaulis* var. *"genuina,"* including the type, and only five specimens of var. *palmeri*. The limited material examined by Munz did not allow a complete assessment of the morphological variation and geographic range of the species. Collins (1973) examined approximately 30 herbarium exsiccate identified as *O. multicaulis*. He concluded that an apical tooth on the corolla lobes and stalked glands on the dorsal surface of the anthers could be used to separate it from *O. cooperi*. The presence of some intermediate specimens was noted, but the question of the relationship between *O. cooperi* and *O. multicaulis* was not resolved. Munz (1930) indicated the palatal folds were poorly developed in *O. multicaulis*, but that character does not hold up on close examination.

Over the last three decades, significant new collections have accumulated in various herbaria to augment the data from the earlier studies. For the present reassessment, 226 exsiccate of *Orobanche multicaulis* (var. *multicaulis*) and *O. cooperi* (var. *latiloba*) were examined. Specimens studied were from Arizona, California, Sonora, and Baja California. The nature of *Orobanche* is such that most of the morphological variation is in the inflorescence and flowers. The flowers were examined for typical characters of length, pubescence, nature of the lobes, and shape and vestiture of the stamens. This confirmed that there were no identifiable discontinuities between specimens identified as *O. cooperi* or *O. multicaulis*. Morphologically, the plants appear identical in size, color, floral anatomy, and pubescence. These observations indicate that, in addition to their overall similarity, the two taxa share the characters of stalked glands on the dorsal surface of the anthers (Fig. 3B) and an apical tooth on each of the upper corolla lobes. These features are present in specimens throughout the geographical range of the complex and are generally not present in other species of *Orobanche*. The absence of the apical tooth on corolla lobes and stalked glands on the anthers from some specimens of *O. cooperi* var. *cooperi* is an exception (see discussion below under *O. cooperi*.) Additionally, the two traditionally recognized taxa utilize the same hosts and occur in similar ecological situations. Because the two taxa share important morphological character states, we

conclude that they should be combined under one binomial, *O. cooperi*, based on nomenclatural priority. The result is an expanded circumscription of *O. cooperi* that includes the former *O. multicaulis* var. *multicaulis* and var. *palmeri*. This new combination further supports the conclusion that *O. multicaulis* and *O. dugesii* are not conspecific.

TAXONOMY

The following key is presented to provide identification for species in the *Orobanche ludoviciana* complex in North America and differentiate this complex from the *O. californica* complex. Descriptions follow only for the species and subspecies for which nomenclatural changes have been made.

1. Inflorescence compact or open corymb or corymbose (some subspecies of *O. californica* appear short-racemose) ..... **Orobanche californica** complex (for key, see Heckard 1973)
1. Inflorescences compact or open, simple or compound spike-like racemes ..... **Orobanche ludoviciana** complex

2. Corolla lobes rounded, (rarely deltate and bluntly pointed in *O. ludoviciana*).

3. Corollas 14–20 mm, the tube pale or whitish externally, lips 3–6 mm, rose or dark purple, palatal folds pubescent, anthers glabrous or pubescent, inflorescence uniformly glandular pubescent, not appearing whitish canescent ..... **Orobanche ludoviciana**
3. Corollas 22–36 mm, the tube yellow or whitish externally, lips 5–12 mm, lavender, rose, or sometimes purple, anthers woolly, palatal folds densely pubescent, plants densely glandular pubescent, appearing whitish-canescent ..... **Orobanche multiflora**

2. Corolla lobes pointed, triangular, acute or truncate but then with or without apiculate tooth.

4. Corollas pale yellow with rose- or purple-tinged lobes, glabrous or nearly so, lobes truncate, barely erect, with minutely apiculate tooth, anthers glabrous or nearly so, plants glabrous or nearly so ..... **Orobanche dugesii**
4. Corollas dark purple or lavender or the tube white with dark purple lobes, densely glandular pubescent, lobes pointed, triangular acute or obtuse, distinctly erect, reflexed or revolute, with or without apiculate tooth, anthers usually pubescent, plants densely glandular pubescent.

5. Corollas (12–)16–32 mm, lips 4–10 mm, the lobes erect, reflexed or revolute, with an apiculate tooth, anthers with stalked glands on the dorsal surface (sometimes absent in subsp. *cooperi*) ..... **Orobanche cooperi**
5. Corollas 12–20 mm, lips 4–8 mm, lobes erect or slightly reflexed, lacking an apiculate tooth, anthers lacking stalked glands.

6. Corollas 12–16 mm, dark purple, the distal portion of the tube and lip dark purple, white and purple striped proximally, the lobe tips dark purple; filaments pubescent at base; bracteoles equaling or exceeding the calyx; plants endemic to California; hosts *Garrya and Eriodictyon* ..... **Orobanche valida**
6. Corollas 15–22 mm, the tube pale white or lavender, the upper lip purple or lavender; filaments glabrous at base; bracteoles much shorter than calyx; plants not from California; hosts Asteraceae.

7. Corollas 15–20 mm, the tube narrow, whitish, the lobes narrowly triangular, dark purple; plants of high desert in N Arizona and S Utah; hosts shrubby species of *Gutierrezia* ..... **Orobanche arizonica**
7. Corollas 15–22 mm, the tube slightly flared, lavender, or pallid white with dark purple veins, the upper lobes broadly triangular, purple or pale lavender; plants of riparian areas; hosts annual species of *Ambrosia* and *Xanthium* ..... **Orobanche riparia**

Orobanche Ludoviciana Cooperi
Corolla 15-16 mm. long, lobes ca. 5 mm., triangular, acute but not abruptly acute, palatal folds prominent. The rather long (fully 9 mm.) and lanceolate calyx-lobes, and tendency of the caulin bracts to be acute rather than rounded, apparently are characters suggesting intergradation with var. gemina. (RHP, 1935)
PLANTS ARIZONA
Orobanche Ludoviciana Cooperi (Gray) Beck
Corolla dull purple.
Marsh Tuba City, Coconino County. Elev. 5050 ft.
No 12867 T. H. KEARNEY R. H. PEEBLES Collectors Sept. 27, 1935
HERBARIUM OF THE UNIVERSITY OF WISCONSIN
REVISION OF OROBANCHE SECT. MYZORRHIZA
OROBANCHE COOPERI (Gray) Heller
ssp. COOPERI
Turner Collins, 1972
copyright reserved
cm

Figure 7. Holotype of *Orobanche arizonica* (*Kearney & Peebles 12867* [US]).

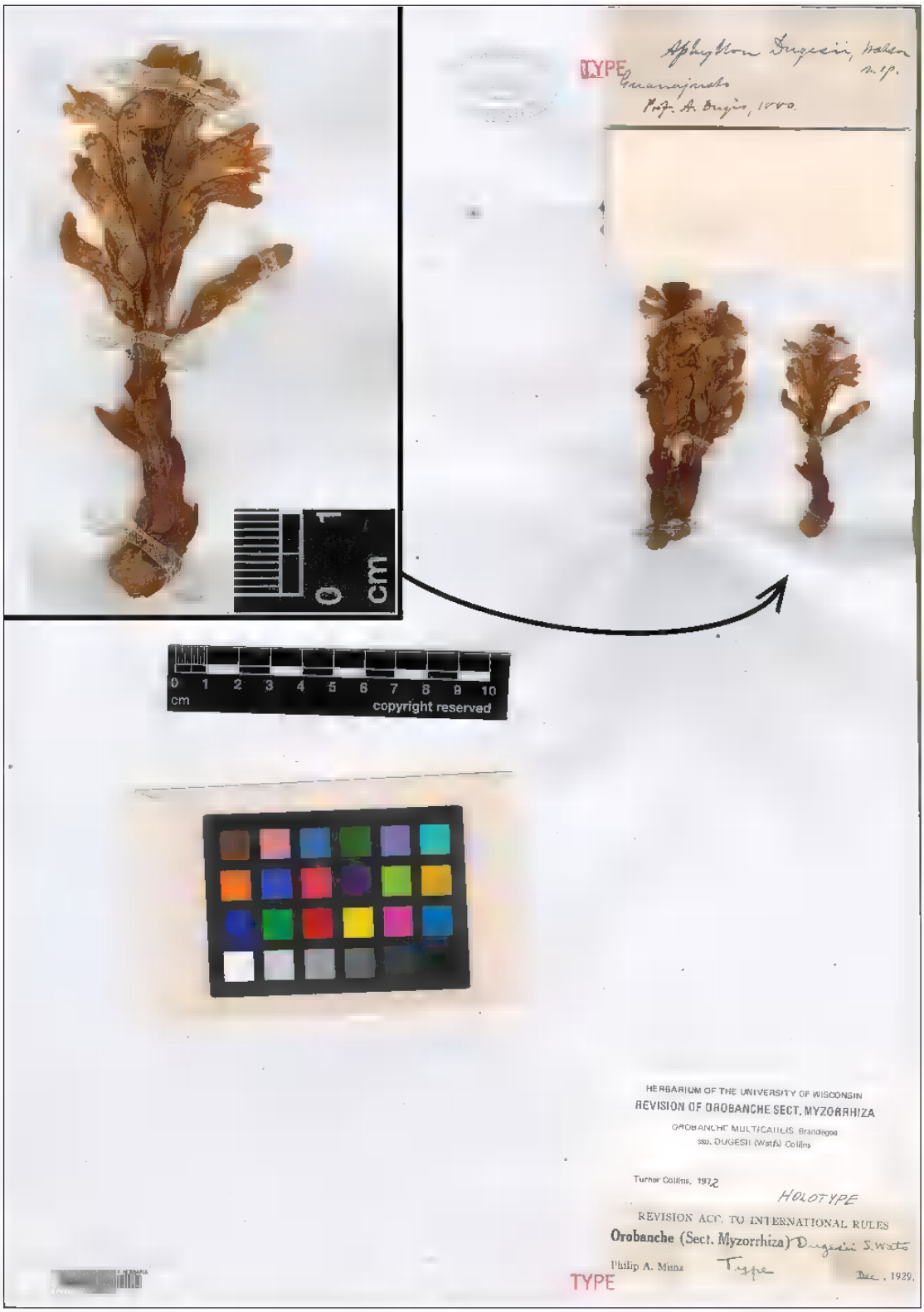

Figure 8. Holotype of *Orobanche dugesii* (*Duges s.n.* [GH]); the inset in the upper left is from the righthand plant on the sheet.

1. **OROBANCHE COOPERI** (A. Gray) A. Heller, Cat. N. Amer. Pl., 7. 1898. *Aphyllon cooperi* A. Gray, Proc. Amer. Acad. 20: 397. 1885. *Orobanche ludoviciana* var. *cooperi* (A. Gray) Beck, Bibl. Bot. 4: 81. 1890. *Myzorrhiza cooperi* (A. Gray) Rydb., Bull. Torrey Bot. Club 36: 695. 1909. **TYPE: USA. Arizona**. Mojave Co.: Ft. Mojave, 1860, *Cooper s.n.* (lectotype [chosen inadvertently by Munz (1930, p. 621)]: GH!; isolectotypes: NY!, US!, K!). Cooper's broomrape, desert broomrape

Plants 5–45 cm, stems simple or branched, base often enlarged, glabrous below. **Roots** numerous, slender and branching, forming an amorphous mass around the infection. **Leaves** 5–13 mm, lanceolate to ovate, apex acute or obtuse. Inflorescences spike-like racemes, purple, copiously viscid-glandular pubescent, sometimes appearing canescent. **Inflorescences** usually dark purple, densely glandular viscid-pubescent. **Bracts** 5–12 mm, lanceolate, purple, apex acuminate, erect or reflexed, glandular puberulent. **Pedicels** proximal 10–30 mm, distal 0–5 mm, bracteoles 2. **Calyces** 7–12 mm, dark purple, deeply five cleft into lance acute-attenuate lobes, densely glandular pubescent. **Corollas** (12–)16–32 mm, the tube white, the lobes purple, constricted above ovary and bent forward, densely glandular-pubescent to glandular-puberulent externally, palatal folds prominent and densely pubescent; lower lip 4–7 mm, lobes extended or spreading or slightly reflexed, dark purple to pale lavender usually with three dark veins in each lobe, apex acute; upper lip 6–10 mm, shallowly cleft, dark purple, erect, reflexed, or revolute, the lobes broadly to narrowly triangular with or sometimes without apiculate tooth, densely pubescent with eglandular hairs. **Stamens**: filaments glabrous; anthers glabrous or tomentulose along the sutures, included, stalked glands on dorsal surface, sometimes absent. **Stigma** peltate, discoid-crateriform, bilaminar, or rhomboid, margins entire or crenulate. **Capsules** 6–12 mm, ovate. Seeds 0.2–0.5 mm, favose, tan to dark brown.. 2n = 48, 72, 96 (Raven et al. 1965; Collins 1973; Heckard & Chuang 1975).

Flowering Jan–May. 30–2000 m. Ariz., Calif., N Mex., Tex., Mexico (Baja California, Chihuahua, Coahuila, Durango, Hidalgo, Nuevo León, San Luis Potosí, Sonora.). Warm desert, sandy flats, washes, dunes, and mountains. Hosts: Asteraceae: Heliantheae (generally *Ambrosia*, *Encelia,* and *Sidneya* [*Viguiera* sensu lato]).

Orobanche cooperi is widely distributed primarily in the Sonoran, and Chihuahuan Deserts. The three entities treated here as comprising this species have been treated at various taxonomic ranks historically (see above). We treat them here as subspecies primarily for the sake of consistency, as this rank has been utilized in recent decades to denote infraspecific taxa in other North American members of the genus *Orobanche* (Heckard 1973; White & Holmes 2001).

From the available counts, it is clear that *Orobanche cooperi* comprises a polyploid complex. In discussing variations in ploidy among California populations, Heckard and Chuang (1975) advised caution in ascribing particular levels of ploidy to the infraspecific taxa known to them. They noted a tendency in California for 2*n*=96 plants to have smaller, shorter-lobed corollas and peltate-bowl-shaped stigmas, compared with 2*n*=48 plants, which they described as having somewhat larger corollas and peltate-crateriform, often bilobed stigmas. However, they were unable to observe the same morphological correlations with ploidy in plants from Baja California and did not study plants from elsewhere in the range of the species (Fig. 5). Heckard and Chuang further noted that plants with 2*n*=72 are possibly hybrids resulting from hybridization in mixed populations. This situation cannot be resolved without additional research, and it is possible that other subspecies might be detected in the future. It should be noted that the only available count for subsp. *palmeri* is 2*n*=48 (Collins 1973, as *O. multicaulis* var. *palmeri*).

Key to subspecies

1. Corollas 22–32 mm, lips 6–10 mm, upper lobes erect or reflexed, with an apiculate tooth: anthers pubescent, with stalked glands on dorsal surface; Sonoran Desert ..... 1b. **Orobanche cooperi** subsp. **latiloba**

1. Corollas 15–22 mm, lips 4–9 mm, upper lobes erect, reflexed, or revolute, with or sometimes without an apiculate tooth; anthers sparingly villous or glabrous, stalked glands sometimes absent (2).

2. Corollas (15–)18–22 mm, lips 5–9 mm, upper lip erect or reflexed, the lobes triangular, with or without an apiculate tooth, anthers glabrous or sparingly villous, stalked glands present or sometimes absent; Sonoran Desert ..... 1a. **Orobanche cooperi** subsp. **cooperi**

2. Corollas (12–)15–20 mm, lips 4–6 mm, lip reflexed or revolute, with or rarely without apiculate tooth; anthers variously pubescent or glabrous, stalked glands few or sometimes absent; stigma peltate or frequently bilaminar; Chihuahuan Desert ..... 1c. **Orobanche cooperi** subsp. **palmeri**

1a. Orobanche cooperi subsp. **cooperi** (Fig. 5).

Stems simple or branched, sometimes enlarged proximally. **Bracts** 8–11(–13) mm, broadly to narrowly lanceolate, dark purple or pale, apex not or only slightly reflexed. **Calyces** 7–10 mm, dark purple or lavender. **Corollas** (15–)18–22 mm, lips 5–9 mm, purple or rarely yellow, upper lobes triangular with or without apiculate tooth, erect, palatal folds pubescent. **Anthers** glabrous or sparingly villous, stalked glands present or sometimes absent. **Stigmas** peltate, bilaminar, or rarely bilobed.

Flowering Jan–Apr. Ariz., Calif., Mex. (Sonora). 30–1000 m. Warm sandy desert and dry washes of the Sonoran Desert.

The range of this subspecies is primarily in Arizona (south of the Mogollon Rim) and southern California and extends into the extreme northern part of Sonora and Baja California. It is sympatric with subsp. *latiloba* throughout almost its entire range.

1b. Orobanche cooperi subsp. **latiloba** (Munz) L.T. Collins **comb. et stat. nov.** *Orobanche ludoviciana* Nutt. var. *latiloba* Munz, Bull Torr. Bot. Club 57: 621, 1931. **TYPE: USA. California**. Riverside Co.: Colorado Desert, 22 Apr 1922, *Munz & Keck 4960* (holotype: RSA!; isotype: US). Fig. 5.

Orobanche multicaulis Munz, Bull. Torrey Bot. Club 57: 613. 1931. **TYPE: Mexico. Baja California**. Purissima, 1889, *Brandegee s.n.* (holotype: C!) (Figs. 5, 7).

Stems simple or frequently branched, often enlarged proximally. **Leaves** 8–12 mm, broad lanceolate, apex obtuse, rarely imbricate proximally. **Bracts** 7–11 mm, broadly lanceolate, dark purple, apex acuminate or obtuse, slightly reflexed. **Calyces** 8–12 mm, dark purple or lavender, lobes sometimes reflexed. **Corollas** 22–32 mm, lips 6–10 mm, upper lobes with apiculate tooth, erect or reflexed, palatal folds densely villous. **Anthers** pubescent, stalked glands on dorsal surface. **Stigmas** peltate or frequently bilaminar, rhomboid.

Flowering Jan–Apr. 30–1000 m. Warm sandy desert and dry washes of Sonoran Desert. Ariz., Calif., Mex. (Baja California, Sonora)

The nomenclatural change to subsp. *latiloba* makes it the most widely distributed subspecies of *Orobanche cooperi*. Although Martin et al. (1998) noted it in the Rio Mayo region of southern Sonora, Mexico, we observed that some specimens examined from that area do not fit into the circumscription of *O. cooper* subsp. *latiloba* or any other recognized taxon of North American

Orobanche. It should further be noted that there are a few sheets from several states elsewhere in Mexico that are anomalous morphologically and require further study.

1c. Orobanche cooperi subsp. **palmeri** (Munz) L.T. Collins **comb. et stat. nov**. *Orobanche multicaulis* var. *palmeri* Munz, Bull. Torrey Bot. Club 57: 613. 1931. **TYPE: MEXICO. Durango**. Durango, 1896, *Palmer 7* (holotype: GH!; isotypes: F!, K!, NY!, US!) (Fig. 5).

Stems 5–30 cm, densely glandular viscid pubescent above, sometimes branched and enlarged below. **Leaves** 6–10 mm, narrowly lanceolate to broadly ovate, imbricate proximally. **Bracts** 7–12 mm, dark purple, narrowly lanceolate to linear, apex acute to acuminate, strongly reflexed, glandular pubescent. **Pedicels** 0–8(–15 proximally) mm. **Calyces** 8–12 mm, dark purple, lobes reflexed. **Corollas** 15–18(–22) mm, abaxial lobes 3–5 mm, reflexed, with 1–3 dark veins, upper lobes 4–6 mm, reflexed or revolute, with or sometimes without apiculate tooth, sometimes truncate, palatal folds densely villous distally. **Filaments** glabrous, anthers glabrous or tomentulose along suture, stalked glands few, often obscure. **Stigmas** bilaminar, rhomboid. **Capsules** 8–12 mm, narrowly ovate.

Flowering Jan–May. (500–)700–2000 m. N. Mex., Tex., Mex. (Chihuahua, Coahuila, Durango, Hidalgo, Nuevo León, San Louis Potosí). Volcanic mountains, sand dunes, dry washes in Chihuahuan Desert. Host: *Sidneya tenuifolia* (A. Gray) E.E. Schill. & Panero (*Viguiera stenoloba* S.F. Blake).

Subsp. *palmeri* is distributed entirely in the Chihuahuan Desert from western Texas and southern New Mexico southward into Mexico, in rocky ravines, dry washes, and on hillsides. It is allopatric with the other two subspecies of *Orobanche cooperi*. Its host association with *Sidneya* sets it apart from the Sonoran Desert subspecies that utilize mostly *Ambrosia*. However, there are relatively few reliable host reports for this taxon and it may parasitize additional perennial species of Asteraceae tribe Heliantheae.

The type collection of subsp. *palmeri* is aberrant in that the inflorescences and flowers are somewhat distorted. This likely occurred as a result of the developing inflorescences having to push up through densely rocky or otherwise highly compacted soil.

2. **Orobanche arizonica** L.T. Collins, **sp. nov. TYPE: USA. Arizona**. Coconino Co.: Near Tuba City, 5500 ft., *Kearney & Peebles 12867* (holotype: ARIZ!; isotype: US!) (Figs. 1, 2, 3A, 4, 5, 8). Arizona broomrape

Similar to *Orobanche cooperi* in its triangular and pointed corolla lobes, but differing in the apiculate lobe apex and glands absent from the anthers.

Plants 5–35 cm, solitary or clustered, rarely branched, stem base not enlarged, glabrous proximally. **Roots** few, short, inconspicuous. **Leaves** 4–10 mm, lanceolate to broadly ovate, glabrous. **Inflorescences** dense spike-like racemes, dark purple or sometimes pale lavender, viscid glandular-pubescent. **Bracts** 5–11 mm, narrowly oblong-lanceolate, apex acute, pubescent. **Pedicels** 0–5(–15 proximally) mm; bracteoles 2. **Calyces** 8–12(–14) mm, deeply 5-lobed, the lobes 6–7(–10) mm, lance-linear to linear-subulate, about equal in length, densely glandular pubescent. **Corollas** 15–20(–22) mm, the tube white, constricted above the ovary, exterior glandular puberulent or pubescent, palatal folds yellow, villous distally with eglandular trichomes; lower lip 3–4 mm, divided to its base into 3 linear lobes 1–2 mm wide, apex acute, pubescent with eglandular trichomes, often with 1–3 purple veins; upper lip ca. 4–6 mm, dark purple, erect, divided about half its length, the lobes triangular-acute or sometimes obtuse-rounded with denticulate margins, 2–3 mm wide, dark purple, densely pubescent with eglandular trichomes. **Stamens**: filaments glabrous or with a few scattered hairs; anthers glabrous or sparsely woolly from sutures of the thecae. **Stigmas** peltate, discoid-

crateriform or rarely somewhat 2-parted. **Capsules** 6–10 mm. Seeds 0.3–0.5 mm, favose, tan to brown. 2n = 48 (Collins 1973).

Flowering June–Aug; pinyon-juniper woodlands, high desert, red sands; 1000–3000 m; Ariz., N. Mex., Utah.

The range of *Orobanche arizonica* is primarily north of the Mogollon Rim in Arizona, northward on the Colorado Plateau, and into the southern half of Utah and adjacent Colorado, but it extends sporadically southward in Arizona to the Chiricahua and Dragoon Mountains (Cochise County). It is often confused with *O. ludoviciana* or has been considered a small-flowered version of *O. cooperi*. It was treated most recently as *O. cooperi* by Heil et al. (2013). The two species can be distinguished on the basis of morphology, habitat, host associations, and phenology. It is parasitic on *Gutierrezia sarothrae* (Pursh) Britt. & Rusby (Asteraceae) and possibly other species of the genus.

Several specimens scattered through the range of *Orobanche arizonica* were exceptional in that they had corolla lobe characters that varied from the majority of specimens examined. These variations included corolla lobes that were somewhat rounded, truncate and denticulate, or lobes that were translucent in prepared specimens. The latter condition is common in *O. corymbosa*. Specific specimens cited with these condition are *Pilsbry s.n., Blakley 1319, Heil 13472, 13897, 17261*, and *Porter 1508*. The cause of this variation was not determined. However, given the proximity of other species raises the possibility of genetic exchange. Further, more detailed studies are needed within pertinent populations. The previously unpublished chromosome number from Collins (1973) is vouchered by two specimens from San Juan Co., Utah: *Collins 1538, 1539* (UWM). These were originally reported as *O. cooperi* subsp. *cooperi*, but the voucher determinations were reevaluated during the present project.

Specimens examined. **USA**. **Arizona**. Apache Co.: 10 mi N of Red Mesa Trading Post, 22 Aug 1952, *Deaver 4034* (ARIZ); Navajo Ind. Res. N end of Corrizo Mts., 3 Aug 1911, *Standley 1514* (US); Red sand dunes N of jct. Hwy 191 and 64, 4 Jun 2001, *O'Kane et al. 5213* (SJNM); Along White House Trail Canyon de Chelly Nat. Mon., 15 Jun 1973, *Dennis s.n.* (ARIZ); Active dunes N. side of Comb Ridge, ¼ mi. E of Navajo Co. line, 17 Aug 2001, *Heil & Clifford 17351* (SJNM); S end of Ventana Mesa, 3 mi W of Hwy 191, 4 mi N of Hwy 4, 27 May 1986, *Reeves 8286* (SJNM). Cochise Co.: 8 mi N of Portal 29 May 1952, *Blakley 1319* (DES); Buckeye Canyon, Chiracahua Mts., 3–30 Nov 1906, *Pilsbry s.n.* (PH); Cochise Stronghold, Dragoon Mts., 12–16 Oct 1910, *Pilsbry s.n.* (PH). Coconino Co.: Warm Springs Canyon, Kiabab Plateau, 30 Sept 1948, *Goodding 409-48* (ARIZ); Between Winslow and Flagstaff, 6 Jun 1935, *Peebles 12001* (ARIZ); 5 mi S of Tuba City, 8 Jun 1937, *Peebles 13362* (ARIZ); S of Navajo Mountain and Tin Can Canyon, 16, Aug 2001, *Heil & Clifford* 17261 (SJNM). Graham Co.: 12 mi NW of Duncan, 3 May 1973, *Holmgren 7066* (RSA). Navajo Co.: between Winslow and Holbrook, 21 May 1934, *McKelvey 4559* (A); Little Captain Valley along Comb Ridge, 16 Sept 2001, *Heil et al. 18064A* (SJNM); 1.5 mi NW from jct to Chilchinbito on Hwy 59, 24 Aug 2001, *Heil & Mietty 17622* (SJNM); Between Kayenta & Betatakin, 12 Sept 1938, *Eastwood & Howell 6571* (CAS); 5 mi NE of Holbrook, 18 Jun 1901, *Ward s.n.* (US); 13 mi S of Holbrook on Hwy 77, 24 Jun 1951, *Turner 2671* (WS); 8 mi N of Winslow, 22 May 1945, *Goodding 29-45* (ARIZ); Warm Springs Canyon below Ryan, 30 Sept 1948, *Goodding 409-48* (ARIZ). **Colorado**. Mesa Co.: Colodaro National Monument, mouth of Ute Canyon, 31 May 1982, *Weber, Wittman & Rector 16119* (COLO). **New Mexico**. Grant Co.: Red Rock CCC Camp, on *Gutierrezia*, 16 May 1935, *Maguire 11408* (NY). Rio Arriba Co.: BLM Rd 370, 5 mi E of Hwy 537, 28 Aug 1999, *Heil 13897* (SJNM). San Juan Co.: N of Waterlow in sand, 28 Jun 1984, *Porter 84*-420 (SJNM); Bisti Badlands, Di Na Zin Wilderness, 12 Aug 1986, *Porter 1508* (SJNM); San Juan floodplain, ½ mi NW of Head Canyon, 2 Jul 1999, *Heil 13472* (SJNM). **Utah**. Emery Co.: Capitol Reef Park, ½ mi N of Middle Desert Wash, 7 Jun 1986, *Heil 2547* (SJNM); Farnham, 29 Jun 1898, *Jones s.n.* (RSA). Garfield Co.: 2 mi NW of Four Mile Bench, 13 May 1987, *Heil 3107* (SJNM);

Dixie National Forest, 8 mi N of Escalante, 11 Aug 1965, *Holmgren et al. 2420* (NY). San Juan Co.: Copper Canyon, 16 mi NW of Oljeto Post, 18 Jun 1938, *Cutler 2268* (MO); San Juan Canyon, 1 mi from Mexican Hat, 20 Jun 1938, *Cutler 2308* ((MO, NY); Copper Canyon Badlands, 11 Jun 1995, *Holmes 403* (SJNM); Monument Valley, 22 Jun 1944, *Holmgren 3423* (US); Rainbow Bridge National Monument, 7 Jun 1961, *Mason & Phillips 1932* (ARIZ); 10 mi S of Montezuma Creek, 29 May 1984, *Porter 84-273* (SJNM). Washington Co.: St. George, 1874, *Parry s.n.* (MO); 5 mi NE of Kolob Arch, Timber Creek Trail, 18 Aug 1987, *Thorn & Franklin 5641* (SJNM). Wayne Co.: Capitol Reef Park, 0.5 mi N of confluence of Polk and Deep Creek, 3 Jun 1993, *Heil & Schles 7539* (SJNM); Capitol Reef Park, N entrance, Hwy 24, 25 Jun 1987, *Porter 5086* (SJNM).

3. Orobanche dugesii (S. Wats.) Munz, Bull. Torr. Bot. Club 37: 613. 1931. *Aphyllon dugesii* S. Wats., Proc. Amer. Acad. 18:132. 1883. **TYPE: MEXICO. Guanajuato**. 1880, *Duges s.n.* (holotype GH!). (Figs. 5, 6). Duges' broomrape

Plants 5–12(–23) cm, stems simple or occasionally branched above, glabrate, pallid-yellow, tan, rose- or purple-tinged. **Roots** usually few, short, sometimes in a globose mass, 10 mm or less. **Leaves** 5–10(–13) mm, lanceolate to ovate, apex obtuse, glabrous or with ciliate margins. **Inflorescences** spike-like racemes, glabrous or nearly so. **Bracts** 6–9 mm, lanceolate, apex acuminate, mostly appressed, yellowish or purple. **Pedicels** 0–4 (proximal –15) mm; bracteoles 2. **Calyces** 7–9 mm, yellowish or purple, deeply 5-cleft into lance acute-attenuate lobes. **Corollas** 12–17 mm, pale yellow tinted with purple, tube constricted above ovary and only slightly bent, glabrous, or glabrate, palatal folds glabrous; abaxial lip 3 mm, lobes extended, pale yellowish or rose tinged, apex truncate with minute tooth; adaxial lip 3–4 mm, shallowly cleft, yellowish, rose tinged or purple, slightly erect, the lobes obtuse or truncate with apiculate tooth, glabrous or nearly so. **Stamens**: filaments glabrous; anthers glabrous, included. **Stigmas** peltate, discoid-crateriform, or bilobed. **Capsules** 7–9 mm, ovate. **Seeds** 0.2–0.5 mm, favose, dark brown.

Flowering Jan–May. 2000–2500 m. Mexico (Guanajuato, Jalisco, Michoacán, Oaxaca, Puebla).

The geographic distribution of *Orobanche dugesii* seems to be associated mainly with the Trans-Mexican Volcanic Belt of central Mexico (Clausen 1959). Host data are unreported on most specimens. A report of "buffalo grass" as a host is questionable, as there are no valid reports of grasses or monocots as host plants for *Orobanche* sect. *Nothaphyllon*.

Of the several specimens examined, most were collected between 1880 and 1910. The most recent collections were one each from 1938 and 1940. The incomplete data on ecology, geographic distribution, and hosts results in an incomplete presentation of *Orobanche dugesii*. Thus no formal taxonomic revision is presented here.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to the curators of the following herbaria for the loan of specimens and permitting us to retain the collections for an extended period of time, as well as to others who granted access to their collections on-site: A, ARIZ, CAS, COLO, F, GH, MO, NY, PH, POM, RSA, SJNM, TEX, US, UWM, and WSU. Our thanks also go to Kenneth Heil of San Juan College for assistance with field work and access to his rather extensive collection of this new taxon and to Marianne Jensen and Al Schneider for sharing useful photographs of living plants and flowers. The present research was carried out in conjunction with a forthcoming treatment of the genus for the *Flora of North America* Project and our coauthor for that treatment, Alison Colwell, provided useful early discussion that helped to shape our thoughts on the uniqueness of *Orobanche arizonica*.

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A SURVEY OF THE *SPOROBOLUS COMPOSITUS* AND *SPOROBOLUS VAGINIFLORUS* COMPLEXES (POACEAE) IN TEXAS

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ABSTRACT

The results of a survey of all TEX/LL collections for *Sporobolus compositus* and *S. vaginiflorus* complexes in Texas is presented and the resulting distributions are mapped. The primary differentiae utilized for this study are discussed and a key is provided to the taxa recognized here. *Sporobolus ozarkanus* is recognized at the species level but seems to be rare in Texas and was not in the TEX/LL collections. Few specimens of *S. neglectus* and *S. compositus* var. *macer* were found. Most common in the eastern half of Texas are *S. compositus* var. *drummondii* and *S. clandestinus*, which are often sympatric.

This morphological and distributional survey of Texas *Sporobolus* taxa with narrow spikelike panicles, relatively large spikelets and cleistogamous habit is the result of an examination of the holdings at TEX/LL herbaria begun in 2001 (Harms 2002). These taxa fall into two groups, corresponding to very broadly circumscribed species recognized by Turner et al. (2003): the perennial *Sporobolus compositus* (essentially the *S. asper* complex of Riggins 1977) and the annual *S. vaginiflorus* complex (the 'annual cleistogamous species' of Riggins' 1969 thesis). Initially I followed the treatment of Reeder (in Gould 1975, and based in part on Riggins 1969), which divided each group into additional species as follows:

(1) perennial
S. clandestinus (Biehler) Hitchc.
S. compositus (Poir.) Merr., including
var. *compositus*
var. *drummondii* (Trin.) Kartesz & Gandhi
var. *macer* (Trin.) Kartesz & Gandhi
(2) annual
S. vaginiflorus (Torr. ex Gray) Alph. Wood
S. ozarkanus Fernald
S. neglectus Nash

However, as a point of departure for the present study I use the Flora of North America treatment by Peterson, Hatch, and Weakley (2003). They treated the taxa at the levels listed above except that *S. ozarkanus* is treated at varietal rank: *S. vaginiflorus* var. *ozarkanus* (Fernald) Shinners. In their treatment, like most before it, annual versus perennial habit is the first couplet in the key to all species and thus, of the species listed above, the annual species key out far from the perennial ones, despite many morphological similarities and potential confusion (see below). Indeed, recent molecular evidence (Peterson et al. 2014) has shown that these two complexes together form the monophyletic *Sporobolus* sect. *Clandestini* P.M. Peterson and are thus each others' closest relatives.

Table 1 gives the relevant sections of the keys of Peterson et al. (2003), condensed and combined to cover just the taxa under study here. Note that the distinction of *Sporobolus clandestinus* and *S. compositus* is given twice by virtue of rhizomatous forms in both taxa. As will be

clear below, I recognize *S. ozarkanus* at species rank based on the work of Riggins (1969) and Yatskievych (1999).

I was drawn into this study partly by the apparent confusion and disagreement on the identification of material in the TEX and LL herbaria. For all but 17 of the 176 TEX and LL specimens from Texas examined within these two complexes, determinations had been made earlier by four outside specialists: F.W. Gould, author of *The Grasses of Texas* (Gould 1975); S.L. Hatch, Director of the Tracy Herbarium and co-author of the above-cited 2003 Flora of North American treatment of *Sporobolus* (Peterson et al. 2003); R.L. McGregor, one of the principal authors of the Flora of the Great Plains (Great Plains Flora Association 1986) and curator of KANU herbarium which now bears his name; and R.L. Riggins, author of studies of both the annual (Riggins 1969) and perennial (Riggins 1973, 1977) complexes. It was evident early on that the specialists had difficulty identifying the collections. For 95 collections in the complex having at least two expert determinations, 25 percent showed lack of agreement. Moreover, for 10 plants, collectors or specialists did not agree as to which complex it belonged, and one collection contained specimens of *S. vaginiflorus* as well as *S. clandestinus* (Figs. 1–4). And once I had developed some knowledge of the groups (as discussed below), on occasion I disagreed with all specialists when collections with pubescent lemmas had been judged to be *S. compositus* (Fig. 5).

Below, I discuss a number of characters that are used in the FNA and other keys, problems with their application, and other, often overlooked characters that seem to offer surer identification. I then offer a key that incorporates these observations, to be used in conjunction with or instead of the existing keys.

Annual vs. perennial distinction

Subsequent to Hitchcock (1935, p. 232), most keys to American species of *Sporobolus* place the annual versus perennial choice as the first couplet. Hitchcock, later in his key, then distinguishes both *S. clandestinus* and *S. vaginiflorus* from their closest relatives by "lemma pubescent." The annual vs. perennial distinction, although correct, does not seem to be easily applied; first-year or freshly mown perennials may appear to be annuals. Conflicting determinations of 9 TEX/LL collections involved the annual *S. vaginiflous* and a perennial from the *S. compositus* complex, primarily *S. clandestinus* (cf. Fig. 2). Difficulty in determining annual/perennial habit might well have led to the confusion of these two taxa. In all such cases, the presence or absence of the hook cell texture unique to *S. vaginiflorus* provided an unambiguous determination.

Lemma vestiture

Lemma vestiture, however, provides an alternative diagnostic feature that can be used in conjunction with or even instead of habit. The lemma vestiture of *Sporobolus vaginiflorus* (Harms & Mendenhall, submitted) and *S. ozarkanus* (Valdés-Reyna & Hatch 1991) is unique within *Sporobolus*; both taxa are shown by SEM scans to be densely populated with "hooks" (Fig. 6). [Following Ellis (1979), a hook is a small process having a rounded base and terminating in a short barb bent toward the lemma tip.] I first noticed these during my examination of the TEX/LL holdings with a dissecting scope at 40X (Fig. 7), although at that magnification I described them (Harms 2002) as "a distinctive minutely papillate surface texture." I have wondered why this distinctive surface texture has not been noted in the major taxonomic literature; e.g., Reeder 1975; Yatskievych 1999; Peterson et al. 2003. An early examination of *Sporobolus* florets by Colbry (1957) described the *S. vaginiflorus* surface in this way (p. 13):

> "usually sparingly pubescent; microscopically striate with shiny conical glands (6 specimens observed in which the indumentum consisted of these shiny, conical glands alone)."

Although Colbry's conical glands appear to represent hooks, I am puzzled by her comment that they occurred with no macro hairs present — perhaps the plants were immature and hairs had not yet developed. For *S. ozarkanus* Riggins 1969 also noted this (p. 67):

> "Presence or absence of floret pubescence is the only character which distinguishes the forms [RTH: of *S. ozarkanus*]. Glabrous florets are often covered with small conical projections.

But the significance of these observations has not been noted in the literature. Although the hook structure is not always clear with a dissecting microscope, it does not require a scanning electron microscope. A compound microscope does show the hook at higher magnifications, noted also for the glabrous form of *S. ozarkanus* (Figs. 8-10).

I consequently propose an alternative key in which the first split is based on lemma hook vestiture rather than habit. *Sporobolus neglectus* would then differ from *S. compositus*, which also has glabrous lemmas, by its small spikelet size (1.6–3 mm long). In this regard I note that one *S. vaginiflorus* collection with lemmas 4 mm long and pubescent florets within the sheath was determined by the collector as "*S. drummondii*" and subsequently determined as *S. vaginiflorus* as well as *S. neglectus* [Travis Co., *Painter s.n.*].

Lemma vestiture also appears to have caused problems. Until recently all keys used unqualified 'pubescent' vs. 'glabrous' lemma surface as primary differentia in the *Sporobolus compositus* complex (e.g., Hitchcock 1935; Riggins 1973; Gould 1975; Shaw 2012). With few exceptions (e.g., Fig. 5) all experts determined lemmas with clearly visible hairs to be *S. clandestinus*. Less conspicuous pubescence produced less agreement, and with lemma scabridity requiring high magnification the determinations varied a great deal (e.g., Fig. 2, even with a few hairs visible). Drawings such as those in Hitchcock (1935) show much stronger pubescence than I have observed in the TEX/LL collections. Hitchcock noted "lemma sparsely appressed pubescent" and Gates (1937) indicated "appressed pubescent toward the base."

Lemma pubescence presents a number of difficulties. (1) Pubescence is especially difficult to observe at stages prior to full maturity (the case for a number of collections and frequently noted by McGregor; e.g., Fig. 2); (2) the hairs when present are sometimes concealed under glume 1, on the lower third of the lemma; and (3) the appressed hairs, being sparsely distributed over the lemma, may not present a sense of pubescence. Even with a strong hand lens, field identification may not be possible. In a sampling of *Sporobolus clandestinus* specimens collected in early August in Hays Co., with numerous empty glumes and several having set seed, with florets separated from the spikelet, not all lemmas revealed hairs; some lemmas showed hairs on only one side; and when present, pubescence was often restricted to the bottom portion of the lemma. These same observations seemed to be borne out by the herbarium specimens as well. Lemma pubescence also seemed to vary by position on the inflorescence, with spikelets higher on the panicle less likely to reveal any hairs, again perhaps a function of maturity.

All lemmas with even limited pubescence showed scattered scale-like scabridity on their upper portions. These are prickles, seen clearly only under very high magnification, i.e., with SEM scans (Fig. 11). [Following Ellis (1979) a prickle is a pointed structure similar to a hook but larger and with an oval or elliptical base.] But at 45X (Fig. 12) one can discern this texture and its difference from the truly glabrous lemmas of *Sporobolus compositus* specimens for which general agreement existed. With a compound microscope the difference is clearer (Figs. 13-15).

Indeed, in several instances I was forced to conclude that Riggins had based her determination of *Sporobolus clandestinus* solely on this scabridulous texture; and conflicting judgments among the experts tended to involve just those scabridulous lemmas without hairs. In a number of cases, I found that I could use this feature as an indicator that hairs would be found on at least some lemmas of a specimen for which they might not have been clearly visible on lemmas of the most easily scanned spikelets. In my 2002 report I used the term "scabridulous," suggested by Tom Wendt, who was supervising my review of the collections. I was about to prepare a new key for the complex when I was pleasantly surprised by the FNA article of Peterson et al. (2003), with the differentia stated as "Lemmas minutely pubescent **or scabridulous**."

Wet pericarp behavior

Wet pericarp behavior provides a second important character distinguishing *Sporobolus clandestinus* from *S. compositus* (and most other taxa of the genus) in that the pericarp of the former is not gelatinous when moist or wet, not noted by Hitchcock (1935) or Colbry (1957). But the key of Riggins (1973) employs "pericarp loose when moist" vs. "pericarp gelatinous when moist" (p. 103); where "loose" implies "not gelatinous." Her text clarifies the issue with this:

> "The mature fruit of *S. asper* has a gelatinous pericarp which swells and slips from the seed when moist. The pericarp of *S. clandestinus* is loose and can be removed with a scalpel when moist." (p. 29) and " ... the consistent association of lemma pubescence and the absence of a gelatinous pericarp."

Riggins 1969 also used this feature to distinguish *Sporobolus neglectus* (p. 38), an important character given that the type of *S. ozarkanus* is also glabrous.

> Pericarps of *S. neglectus* caryopses become gelatinous when in water and the seed is liberated. Pericarps of *S. vaginiflorus* and *S. ozarkanus* become loose when moist and can be removed with a microscapel. They do not become gelatinous, nor is the seed liberated.

The action of the typical *Sporobolus* wet pericarp was well known in the 19th century and described in detail for *S. cryptandrus* in Beal (1886):

> "Inside the ovary and about the seed there is a gummy secretion. When about ready to escape or at a certain stage of maturity, if water be applied to the panicle, in a short time the seeds come forth. ... The action of the water on the ovary seems to be purely mechanical and is explained in well known works on physics. The water enters the ovary faster than the gum can escape. The ovary is flattened and splits on the side next the palea" (p. 247).

Also new with the FNA key is a clear statement of the difference in wet pericarp reaction separating *Sporobolus clandestinus* from *S. compositus*, i.e., "loose but neither gelatinous nor slipping from the seed when wet" vs. "gelatinous, slipping from the seed when wet" (Figs. 16-18). This differentia is not easily applied with older collections or immature spikelets. Although I had clear results with fresh grains (not available to me for *S. compositus* var. *compositus*), collections older than 35 years did not react to wetting. The collections reviewed only rarely showed notations that this test had been applied.

Habit and vegetative differences

Habit and vegetative differences are often useful but may be difficult. Rhizomatous forms of *Sporobolus clandestinus* are recognized in the FNA description and key. Although these were noted by Riggins (1973), the primary differentiae of her key were focused on the lemma and pericarp. Subsequent treatments (e.g., Reeder 1975) did not seem aware of this form. Shaw (2012) noted it in the description, but in his key *S. clandestinus* is under "plants without rhizomes." Not surprisingly the collection *Parks s.n.* [Brazos Co., 17 Oct 1946, TEX], clearly rhizomatous but with strongly

scabridulous lemma, was identified by all except Riggins as *S. compositus* var. *macer* (Fig. 3). In contrast, a less obviously rhizomatous collection with pubescent lemmas, *Gould 11047* from adjacent Robertson Co., was seen by all as *S. clandestinus* (Fig. 4).

TEX/LL has very few collections of *Sporobolus compositus* var. *macer* — 2 at the time of my initial survey, both from Bastrop Co., and only 3 of rhizomatous *S. clandestinus*. Apart from the presence of rhizomes, the keys of Riggins 1977 & Peterson et al. 2003 give no other differentiae, nor do their descriptions provide more than an indication that *S. compositus* var. *macer* is somewhat smaller (although considerable overlap exists; e.g., Riggins: lemma length 2.7–5.4 mm vs. 3.2–6.9 mm for *S. compositus* var. *asper*; Peterson et al. don't give variety spikelet lengths). Riggins 1977 noted that very few specimens of *S. compositus* var. *macer* had been collected — a situation that still holds in Texas and which limits evaluation of morphological variation. If production of rhizomes is sufficient distinction to justify recognition of a varietal entity, then a rhizomatous variety of *S. clandestinus* awaits description — the known rhizomatous collections in Texas are geographically compact in three counties: Brazos, Robertson, and Bastrop (Map 1). Var. *macer*, the rhizomatous form of *S. compositus*, is known from three coastal plain counties in Texas (Map 1); the type is from an unspecified locality in Louisiana.

A panicle size distinction is also noted in the FNA key; i.e., for *Sporobolus clandestinus*: "panicles 5-11 cm long, 0.04-0.3 cm wide"; for *S. compositus*: "panicles 5-30 cm long, 0.4-1.6 cm wide." Although this is generally valid, large specimens of the former are found; e.g., *Brown 3397* (Travis Co.; Fig. 5), with a panicle > 23 cm long, ± 9 mm wide. Although this collection has clearly pubescent lemmas, all external annotations were *S. compositus*.

Within *Sporobolus compositus*, var. *drummondii* is most distinct in habit and size (Figs. 19-20). Collections with spikelets less than 4.2 mm long were all determined as *S. compositus* var. *drummondii*. In field observations it stands out as large lax dense tufts with narrow leaves, often 5–7 cm at the base with long weak culms, to 4 feet long, weighed down by the inflorescence. In late fall the large tufts become a prostrate tangled mass of leaves and culms. Young plants and mowed or grazed plants may have shorter, somewhat more erect culms.

In a recent study of vegetative differences of Texas Hill Country grasses, Hagenbuch and Lemke (2015) found "no vegetative characters that can be used to reliably distinguish between" *Sporobolus clandestinus* and *S. compositus* (p. 64). Their study did not include *S. ozarkanus* or *S. neglectus*, perhaps following Turner et al. (2003), which recognized only *S. vaginiflorus* among the annual taxa, although Shaw 2012 shows *S. neglectus* in their study area; i.e., Kerr and Bandera counties on the Edwards Plateau.

Distributions for the taxa in these two complexes in Texas as represented in the TEX/LL herbaria as of 2014 as determined by me are shown in Maps 1-3. The *Sporobolus compositus* complex (Map 1) is found primarily in the eastern two-thirds of Texas, roughly from the northern boundary south to the Nueces River. The most widespread taxa of this group are *S. clandestinus* and *S. compositus* var. *drummondii*, commonly sympatric in central areas and often in close proximity. *Sporobolus compositus* var. *compositus* is uncommon south of north Texas, with only sporadic representation. It is perhaps present outside its natural range by virtue of inclusion in introduced seed mixtures, as noted by Colbry (1957): "seldom planted intentionally but is usually present in the commercial mixed bluestem (*Andropogon* spp.) used for seeding purposes." It is common on Central Texas plant lists to the exclusion of *S. clandestinus*, perhaps because the latter is the common "tall dropseed" in the area and the two are not easily separated in the field; or because some authors (e.g., Turner et al. 2003) have combined the two taxa. *Sporobolus compositus* var. *macer*, collected only from sandy areas in southeast Texas, was sympatric with *S. compositus* var. *drummondii* and *S. clandestinus* in a small area of McKinney Roughs Nature Park in Bastrop Co.

The distribution of *Sporobolus clandestinus* lemma vestiture types, Map 2, did not indicate a geographic pattern. All three types plotted were collected in Travis Co. and were noted in the field in Hays Co. I suspect that the differences reflect the stage of maturity. One very robust plant in cultivation seemed to have glabrous lemmas at anthesis in mid summer, but mature lemmas in the fall were clearly pubescent.

Sporobolus neglectus, Map 3, seems to be rare, with only two collections since the 1960s, both in Grayson Co. on the Oklahoma border. The distribution of collections shows no perceptible pattern. Shinners' (1954) newly created *S. vaginiflorus* var. *neglectus* (Nash) Shinners was said (p. 29) to be represented in Texas by *Shinners 16402* (SMU, US); but Riggins (1969, p. 49) stated "I have examined the Shinners specimen and verified the identity as *S. vaginiflorus*." Its presence in "native grass and legume samples and in *S. cryptandrus* samples" (Colbry 1957) (that is, in reseeding mixtures) may also account for its presence in the Texas flora.

With *Sporobolus vaginiflorus* collections I measured relative glume/floret lengths (i.e., glumes longer, shorter, or the same length as florets; Map 3) and also noted the presence/absence of lateral lemma veins, giving 6 combinations, all of which were found with no apparent geographic pattern. Variation was found within individual collections as well as within counties. These results call into question the use of glume/floret length and lemma venation in the FNA key

The status of *Sporobolus ozarkanus* in Texas

I found no specimens of *Sporobolus ozarkanus* from Texas in the TEX/LL herbaria, and in my opinion its status in Texas remains problematical. In the 32 collections *S. vaginiflorus* from TEX/LL examined by Riggins, McGregor, and Hatch, Riggins determined all to be *S. vaginiflorus,* but 17 were determined to be *S. ozarkanus* by McGregor or Hatch. Gould did not determine any TEX/LL collection to be *S. ozarkanus*. At that time Riggins did note *S. ozarkanus* among the TEX/LL non-Texas specimens; and she listed (1969) only one Texas collection, from Bowie County in far northeast Texas (*Letterman 77,* MO). Later, Reeder (1975) gave the Texas distribution of *S. ozarkanus* as "Region 7 and the southern portions of regions 4 and 5" [i.e., roughly Edwards Plateau and south Central Texas], areas strongly represented in the TEX/LL collections. Diggs et al. 2006 mapped Texas distributions for *S. vaginiflorus* (p. 1085) as well as *S. ozarkanus* (p. 1077); the distribution of the former is essentially the same as determined by Riggins (cf. Map 3 here), but the latter is shown only for 3 counties, Grayson, Grimes, and San Jacinto, north and east of the areas indicated by Reeder. To my knowledge *S. ozarkanus* with glabrous florets has not been found in Texas, requiring identification to be based on other character traits. Although the keys of Reeder and Diggs et al. allow for glabrous florets, the TEX/LL collections did not include this form.

To some extent the source of these disagreements may stem from the history of this taxon. *Sporobolus ozarkanus* Fernald was published in 1933 (Fernald 1933) based in part on its glabrous florets (p. 109):

> *Sporobolus ozarkanus*, in its long spikelets, narrow lemma and strongly ciliate sheath-orifices is like typical *S. vaginaeflorus*; but its quite glabrous lemmas and strongly pubescent leaves quickly set it apart.

The TYPE specimen, with glabrous florets, is *E.J. Palmer 3133* (GH).

Shinners' 1954 revision of the *S. vaginiflorus* complex also included this taxon, treated as *S. vaginiflorus* var. *ozarkanus* (Fernald) Shinners. Shinners' total justification consisted of two lines with no discussion (p. 29):

> To complete the roster, one extra-limital variety may be added: *S. vaginiflorus* var. *ozarkanus* (Fernald) Shinners, comb. nov. *S. ozarkanus* Fernald, Rhodora 35: 109. 1933.

Shinners had thus created two varieties of *S. vaginiflorus* with glabrous florets (the other being var. *neglectus*), and no key to distinguish them. This new var. *ozarkanus* seems to have persisted into the treatment by Peterson et al. (2003; Table 1), which has no path to recognize the glabrous type form of *S. ozarkanus* Fernald, and distinguishes *S. vaginiflorus* (including var. *ozarkanus)* with "Lemmas strigose" from *S. neglectus* with "Lemmas glabrous."

In her careful and data-rich thesis Riggins (1969) presented a detailed and compelling case for recognizing three taxa in the *Sporobolus vaginiflorus* complex: *S. neglectus* Nash, *S. vaginiflorus* (Torr.) Wood, and *S. ozarkanus* (Fernald). Most significantly she documented forms of *S. ozarkanus* with pubescent lemmas, complicating the use of lemma vestiture as a differentia (Map 5). Her methods were designed to "insure maximum ranges of variation" (p. 30) with large population samples, which has led to considerable overlap and thus difficulties with key diagnostics even when mean values support her conclusions. For example, she notes the overlapping length/width ratios:

> Although the ranges of variation [RTH: for vegetative characters] overlap, the mean values for *S. ozarkanus* are notably different. (p. 29) … The florets of *S. ozarkanus* are shorter and wider than *S. vaginiflorus* florets. The length/width ratio is smaller than the ratio for *S. vaginiflorus*." (p. 72; cf. Fig. 21).

But her key contrasts "floret length/width ratio 1.6–3.3(3.8)" for *ozarkanus* with "floret length/width ratio 2.2–5.7(7.5)" for *vaginiflorus* (repeated in Reeder 1975).

Her finding for lemma venation does not support its use as a differentia (p. 35):

> The lemmas of *S. ozarkanus* consistently have three prominent nerves. The type of *S. ozarkanus* is an immature specimen and the lateral nerves are not immediately obvious. The lemmas of *S. vaginiflorus* are one and three nerved. The three nerved condition is more frequent.

Contrast Peterson et al. 2003: "lemmas always faintly 3-veined" vs. "lemmas usually 1-veined" (p. 119) or Shaw 2012: "lemmas faintly 3-veined" vs. "Lemmas 1-veined" (p. 941). The use of lemma nerves as differentia may well account for the large number of *S. ozarkanus* findings among Texas botanists.

Although the close similarity of *Sporobolus vaginiflorus* and *S. ozarkanus* is indisputable, making identification of herbarium collections difficult, Riggins' study of natural populations leads me to conclude that they are differentiated as separate species. She noted this (pp. 39-42; cf. Fig. 22):

> … one population sample included all three species. Within the population the species are distinct and *S. ozarkanus* predominates with *S. neglectus* and *S. vaginiflorus* less frequent respectively. The population is represented in Fig. 5. [Cf. Fig. 22]. When floret length/width ratios and spikelet lengths are plotted on a scatter diagram the species are recognized. *Sporobolus vaginiflorus* specimens represented have length/width ratios greater than or equal to 3.0. Spikelet lengths of the *S. vaginiflorus* specimens vary from 2.5 to 3.0 mm. All other pubescent florets represented are *S. ozarkanus*.

The distribution of the annual taxa and *Sporobolus airoides* in Missouri is shown in Map 4, based on the online Atlas of Missouri Vascular Plants at Missouri State University. In most counties

where *S. ozarkanus* occurs, it is sympatric with both *S. vaginiflorus* and *S. neglectus*. Further, although the annual taxa are all highly cleistogamous, Riggins' breeding data (1969) suggest the possibility of limited outcrossing (pp. 26-28):

> The presence of the longer anthers with many pollen grains indicates that there is a possibility of chasmogamy for each species. It is not known whether chasmogamy occurs regularly and frequently in wild populations. The percentage of outcrossing would undoubtedly be low since only a few spikelets per plant have the potential for outcrosssing. … Although it is probable that limited outcrossing occurs in natural populations, the variation patterns of greenhouse-grown progeny do not reflect any gene flow between the various phenotypes grown in close proximity.

The molecular study by Peterson et al. (2014) indicates that this taxon is probably the result of ancient hybridization between taxa conspecific with or related to *Sporobolus vaginiflorus* and *S. airoides* (Torr.) Torr., which belongs to a different section. I note that *S. airoides* is sympatric with all three annual taxa in Jackson Co., Missouri (Map 4).

Key for the two complexes (*Sporobolus ozarkanus* based on Yatskievych 1999):

1. Lemma surface minutely papillate (hook cells), with or without hairs, or glabrous; spikelets < 3 mm long.

    2. Lemma surface glabrous, not minutely papillate, pericarp gelatinous, slipping from the seed when wet ..... **S. neglectus**
    2. Lemma surface pubescent or minutely papillate (as seen at 45X), pericarp not gelatinous, nor slipping from the seed when wet.

        3. Glumes slightly longer than the floret; lowermost leaf sheaths hairy on the surface, noticeably inflated, appearing mostly 1.5-3.0 mm wide in profile (do not unfold) ..... **S. ozarkanus**
        3. Glumes usually shorter than the floret; lowermost leaf sheaths often glabrous on the surface, only slightly inflated, appearing 0.8-1.7 mm wide in profile (do not unfold) ..... **S. vaginiflorus**

1. Lemma surface not minutely papillate, with or without hairs; spikelets > 3 mm long.

    4. Lemma surface with scattered hairs or scabridulous; pericarp not gelatinous, nor slipping from the seed when wet ..... **S. clandestinus**
    4. Lemma surface glabrous, not scabridulous;pericarp gelatinous, slipping from the seed when wet.

        5. Plant rhizomatous ..... **S. compositus** var. **macer**
        5. Plant not rhizomatous.

            6. Spikelets > 4.4 mm long ..... **S. compositus** var. **compositus**
            6. Spikelets < 4.2 mm long ..... **S. compositus** var. **drummondii**

ACKNOWLEDGEMENTS

I am indebted to Tom Wendt for his intellectual stimulation and generous expenditure of time during all phases of this project, which began in 2002, and to Guy Nesom for his challenging commentary leading to a improved revision. I also wish to thank John Mendenhall (Institute of Cellular and Molecular Biology microscopy facility, University of Texas at Austin) for providing the scanning electron microscopy images in Figures 6 & 11, Jim Mauseth for the compound microscope images in Figures 9 & 10, Rhonda Riggins for her permission to use portions of her outstanding thesis (Figures 15 & 16, plus numerous passages quoted in the text), and George Yatskievych for locating

and donating to TEX an *Sporobolus ozarkamus* specimen with glabrous florets Thanks are also due to Dwight Romanovicz (Microscopy and Imaging Facility, Institute for Cellular & Molecular Biology, University of Texas -Austin) for use of his lab's sputter coater.

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(1) Plants annual or short-lived perennial flowering the first year.

(5) Lemmas strigose; spikelets 2.3–6 mm long; mature fruits (1.1) 1.8–2.7 mm long.

Sheath bases sparsely hairy; glumes usually longer than florets; lemmas always faintly 3-veined **S. vaginiflorus var. ozarkanus**

Sheath bases usually glabrous; glumes usually shorter then the florets; lemmas usually 1-veined **S. vaginiflorus var. vaginiflorus**

Lemmas glabrous; spikelets 1.6–3 mm long; mature fruits 1.2–1.8 mm long **S. neglectus**

(1) Plants perennial … (6)

(6) Plants with rhizomes (… 11) / Plants without rhizomes (… 34)

(11) Fruits 1-2 mm long; pericarp gelatinous, slipping from the seed when wet; panicles 5-30 cm long, 0.4–1.6 cm wide; lemmas glabrous, smooth **S. compositus var. macer**

Fruits (1.5)2.4–3.5 mm long; pericarp loose but neither gelatinous nor slipping from the seed when wet; panicles 5–11 cm long, 0.04–0.3 cm wide; lemmas minutely pubescent or scabridulous **S. clandestinus**

(34) Lemmas minutely pubescent or scabridulous, chartaceous and opaque; pericarps loose but neither gelatinous nor slipping off the seeds when wet; fruits (1.5)2.4–3.5 mm long **S. clandestinus**

Lemmas usually glabrous and smooth, membranous to chartaceous and hyaline; pericarps gelatinous, slipping off the seeds when wet; fruits 1–2 mm long **S. compositus**

Culms slender, 1-2(2.5) mm thick; upper sheaths usually less than 2.5 mm wide; panicles with 16–36 spikelets per cm2 when pressed **S. compositus var. drummondii**

Culms stout, 2–5 mm thick; upper sheaths usually 2.6–6 mm wide; panicles with 30–90 spikelets per cm2 when pressed **S. compositus var. compositus**

Table 1. The relevant sections of the keys of Peterson et al. (2003), condensed and combined to cover just the taxa under study here.

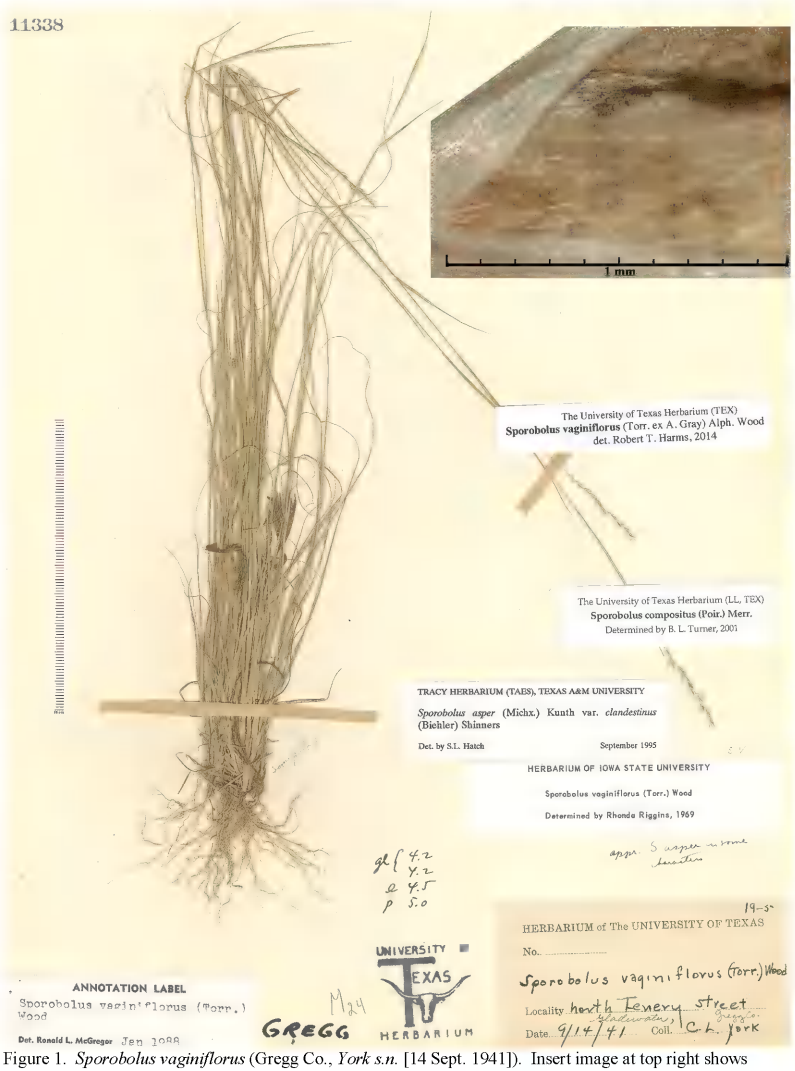

11338
1 mm
The University of Texas Herbarium (TEX)
Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood
det. Robert T. Harms, 2014
The University of Texas Herbarium (LL, TEX)
Sporobolus compositus (Poir.) Merr.
Determined by B. L. Turner, 2001
TRACY HERBARIUM (TAES), TEXAS A&M UNIVERSITY
Sporobolus asper (Michx.) Kunth var. clandestinus (Biehler) Shinners
Det. by S.L. Hatch
September 1995
HERBARIUM OF IOWA STATE UNIVERSITY
Sporobolus vaginiflorus (Torr.) Wood
Determined by Rhonda Riggins, 1969
appr. S asper var. clandestinus
gl 4.2
Y 2
e 4.5
p 5.0
19-s
HERBARIUM of The UNIVERSITY OF TEXAS
No.
Sporobolus vaginiflorus (Torr.) Wood
Locality North Emery Street Gregg Co.
Date 9/14/41 Coll. C.L. York
ANNOTATION LABEL
Sporobolus vaginiflorus (Torr.) Wood
Det. Ronald L. McGregor Jan 1988
GREGG
UNIVERSITY TEXAS HERBARIUM

Figure 1. *Sporobolus vaginiflorus* (Gregg Co., *York s.n.* [14 Sept. 1941]). Insert image at top right shows lemma detail with hook-cell texture. (Cf. Figs. 6–7.)

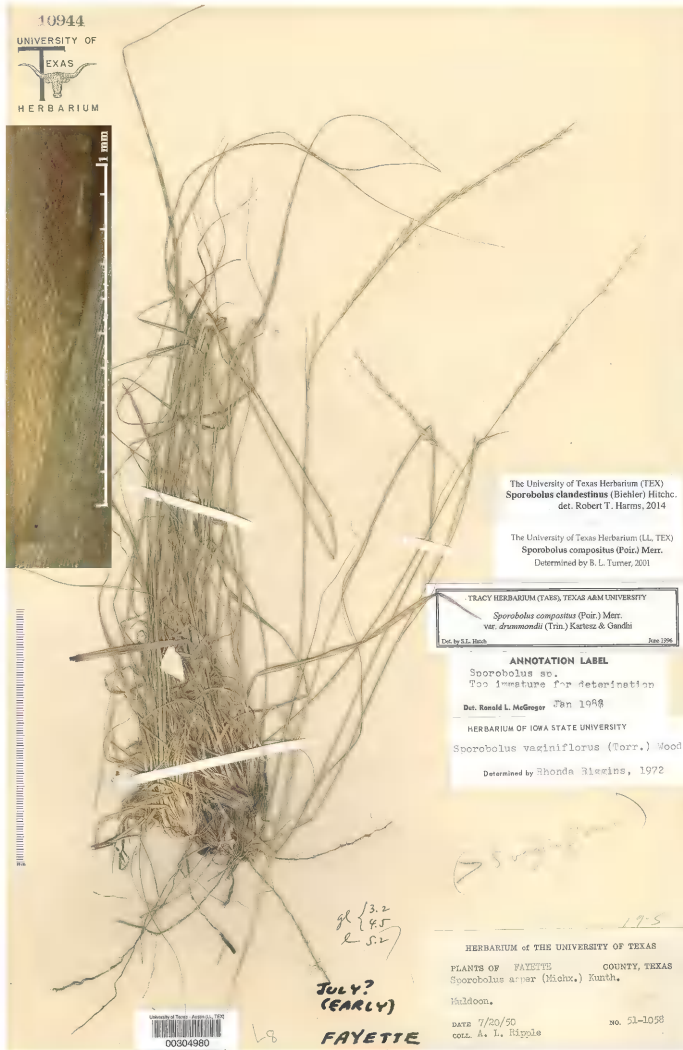


Figure 2. *Sporobolus clandestinus* (Fayette Co., *Ripple 51-1058*). Five different determinations. Insert shows hairs on scabridulous lemma, lacking the hook-cell texture of *S. vaginiflorus*.

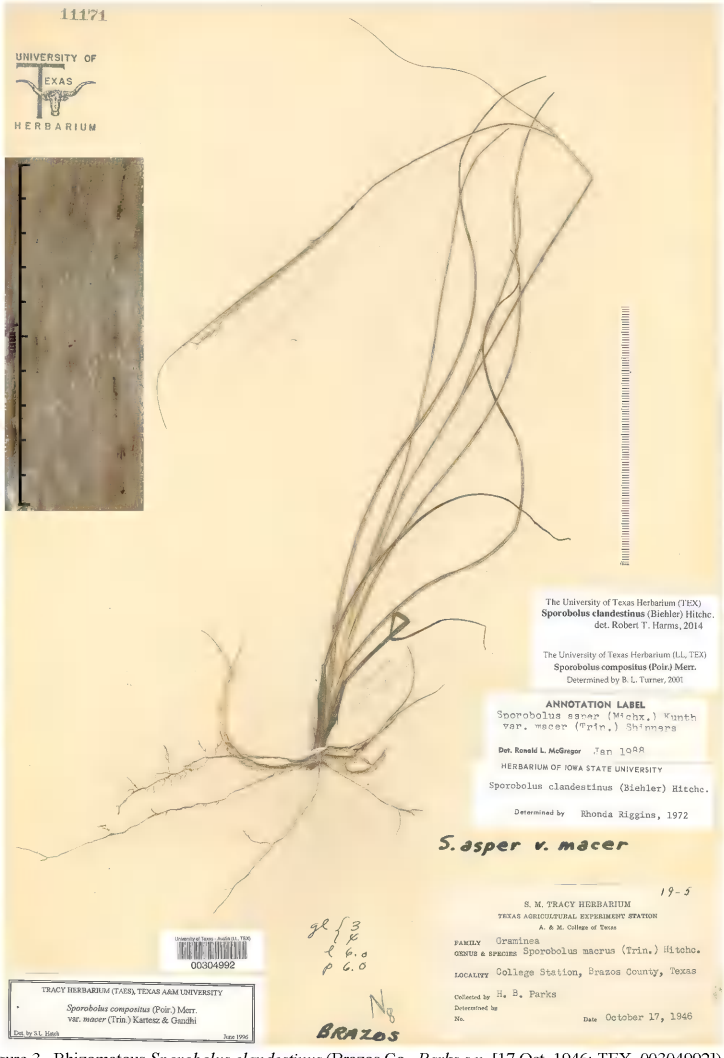

11171
UNIVERSITY OF TEXAS HERBARIUM
The University of Texas Herbarium (TEX)
Sporobolus clandestinus (Biehler) Hitchc.
det. Robert T. Harms, 2014
The University of Texas Herbarium (LL, TEX)
Sporobolus compositus (Poir.) Merr.
Determined by B. L. Turner, 2001
ANNOTATION LABEL
Sporobolus asper (Michx.) Kunth
var. macer (Trin.) Shinners
Det. Ronald L. McGregor Jan 1988
HERBARIUM OF IOWA STATE UNIVERSITY
Sporobolus clandestinus (Biehler) Hitchc.
Determined by Rhonda Riggins, 1972
S. asper v. macer
19-5
S. M. TRACY HERBARIUM
TEXAS AGRICULTURAL EXPERIMENT STATION
A. & M. College of Texas
FAMILY Gramineae
GENUS & SPECIES Sporobolus macrus (Trin.) Hitchc.
LOCALITY College Station, Brazos County, Texas
Collected by H. B. Parks
Determined by
No.
Date October 17, 1946
00304992
TRACY HERBARIUM (TAES), TEXAS A&M UNIVERSITY
Sporobolus compositus (Poir.) Merr.
var. macer (Trin.) Kartesz & Gandhi
Det. by S.L. Hatch June 1996
BRAZOS

Figure 3. Rhizomatous *Sporobolus clandestinus* (Brazos Co., *Parks s.n.* [17 Oct. 1946; TEX 00304992]). It was determined also as *S. compositus* var. *macer* (adjusted for synonomy), but insert shows strongly scabridulous lemma. Compare Figure 4, also with rhizomes, from adjacent Robertson Co.

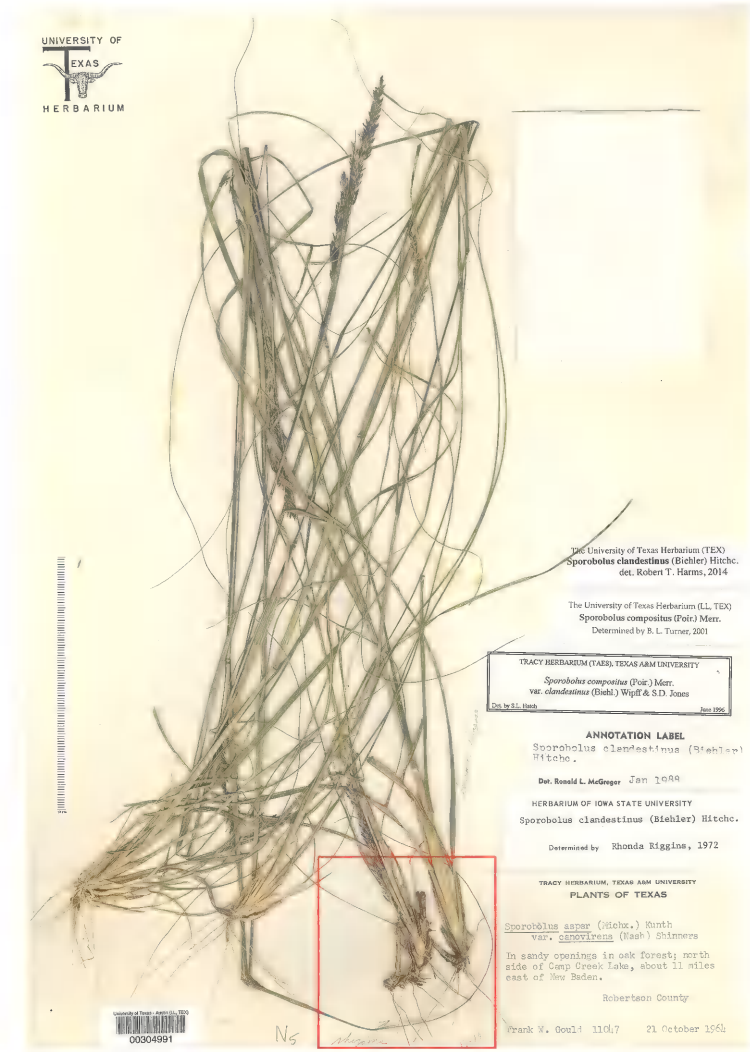

UNIVERSITY OF TEXAS HERBARIUM
The University of Texas Herbarium (TEX)
Sporobolus clandestinus (Biehler) Hitchc.
det. Robert T. Harms, 2014
The University of Texas Herbarium (LL, TEX)
Sporobolus compositus (Poir.) Merr.
Determined by B. L. Turner, 2001
TRACY HERBARIUM (TAES), TEXAS A&M UNIVERSITY
Sporobolus compositus (Poir.) Merr.
var. clandestinus (Biehl.) Wipff & S.D. Jones
Det. by B.L. Hatch
June 1996
ANNOTATION LABEL
Sporobolus clandestinus (Biehler) Hitchc.
Det. Ronald L. McGregor Jan 1989
HERBARIUM OF IOWA STATE UNIVERSITY
Sporobolus clandestinus (Biehler) Hitchc.
Determined by Rhonda Riggins, 1972
TRACY HERBARIUM, TEXAS A&M UNIVERSITY
PLANTS OF TEXAS
Sporobolus asper (Michx.) Kunth
var. canovirens (Nash) Shinners
In sandy openings in oak forest; north side of Camp Creek Lake, about 11 miles east of New Baden.
Robertson County
Frank W. Gould 11047 21 October 1961
00304991

Figure 4. Rhizomatous (red box) *Sporobolus clandestinus* (Robertson Co., *Gould 11047*). All external annotations agree (adjusted for synonomy). Compare Fig. 3 from adjacent Brazos Co.

176585
UNIVERSITY OF
TEXAS
HERBARIUM
The University of Texas Herbarium (TEX)
Sporobolus clandestinus (Biehler) Hitchc.
det. Robert T. Harms, 2014
The University of Texas Herbarium (LL, TEX)
Sporobolus compositus (Poir.) Merr.
Determined by B. L. Turner, 2001
TRACY HERBARIUM (TAES), TEXAS A&M UNIVERSITY
Sporobolus compositus (Poir.) Merr.
var. compositus
HERBARIUM OF IOWA STATE UNIVERSITY
Sporobolus asper (Michx.) Kunth var. asper
Determined by Rhonda Riggins, 1972
HERBARIUM of THE UNIVERSITY OF TEXAS
PLANTS OF TRAVIS Co. TEXAS
Sporobolus asper > var. asperi
Dry roadside ditch near Bee Creek, 24 Sept. 1947.
W.V.Brown #3397 GR-256
Brown
COLLECTOR
ANNOTATION LABEL
Sporobolus asper (Michx.) Kunth var. asper
Det. Ronald L. McGregor Jan 1988
TRAVIS

Figure 5. *Sporobolus clandestinus* (Travis Co., *Brown 3397*). All external annotations were *S. compositus* var. *compositus* (adjusted for synonomy). Insert shows hairs on scabridulous lemma.

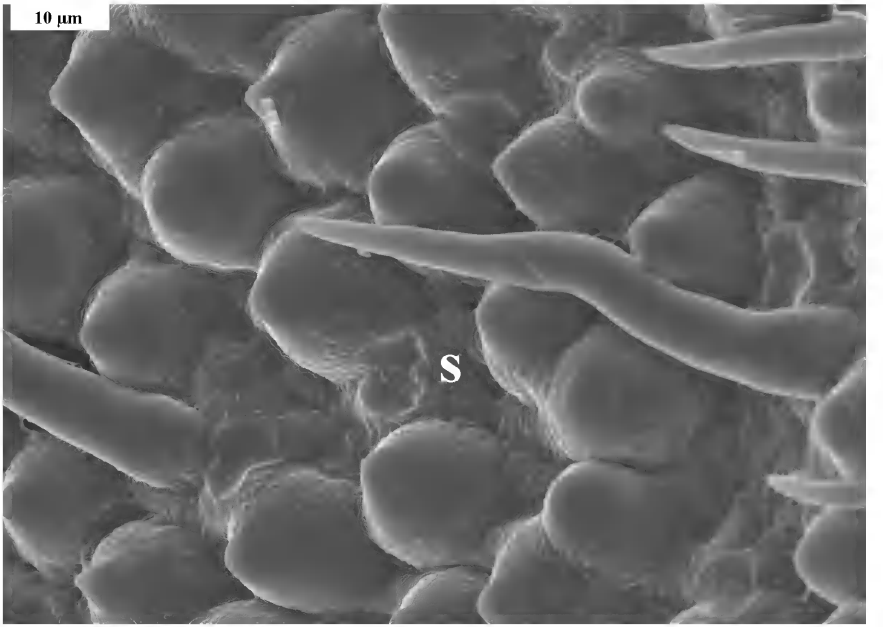


Figure 6. SEM image of *Sporobolus vaginiflorus* hook cells, macro hairs and silica cells (S) at 13,350X. Texas, Hays Co., *Harms 44a* (TEX).

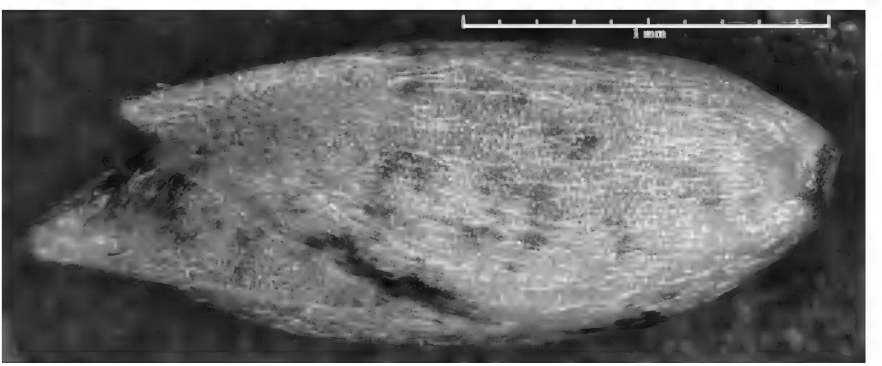


Figure 7. *Sporobolus vaginiflorus* lemma at 45X with dissecting microscope. Texas, Hays Co., *Harms 44a* (TEX).

Figure 8. *Sporobolus vaginiflorus*. The same area at two focal lengths. The double-headed arrows are at the same place in the two images. The red circles show the acute top 'hook' of the cell more or less in focus in the same area as the pink circles (unfocused) on the adjacent image. A macrohair is in focus on the right image. Texas, Hays Co., *Harms 44a* (TEX).

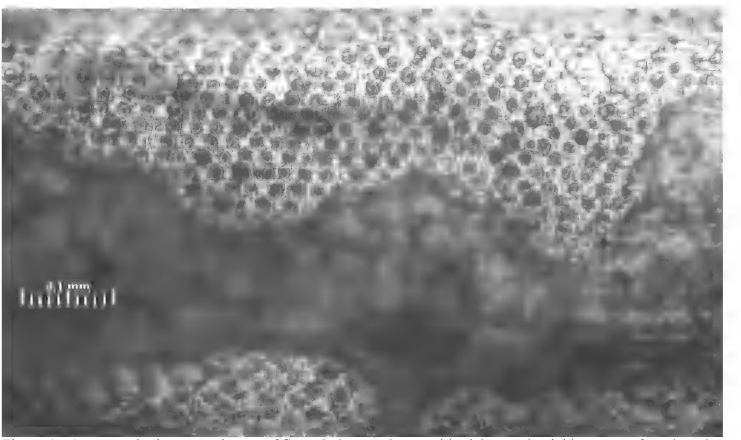


Figure 9. Compound microscope image of *Sporobolus ozarkanus* with glabrous abaxial lemma surface densely populated with hooks. Carter Co., Missouri, *Brant & O'Donnell 7383* (MO, TEX).

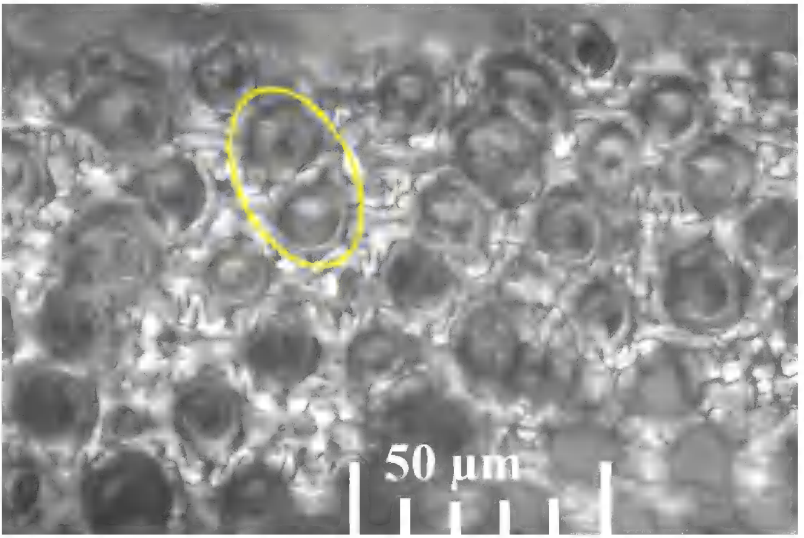


Figure 10. Compound microscope detail of glabrous abaxial lemma surface of *Sporobolus ozarkanus*. Two clearly defined hooks are in the yellow circle. Carter Co., Missouri, *Brant & O'Donnell 7383* (MO, TEX).

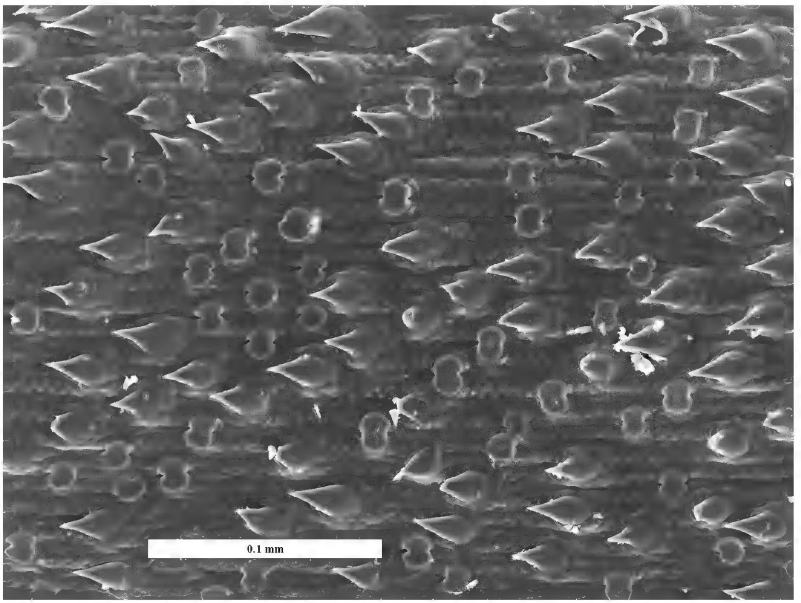


Figure 11. SEM image of *Sporobolus clandestinus* lemma surface with prickle cells, silica cells and long cells at 6,120 X (Texas, Hays Co., *Harms 18* [TEX]).

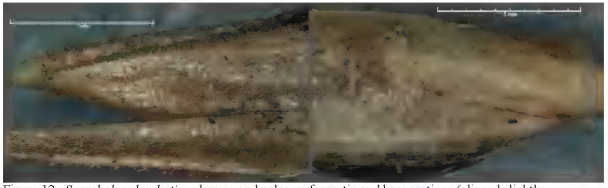


Figure 12. *Sporobolus clandestinus* lemma and palea surfaces, tip and base sections (aligned slightly differently), scabridulous surface with hairs at 45X with dissecting microscope (Texas, Hays Co., *Harms 18* [TEX]).

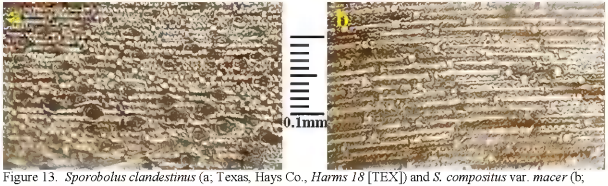


Figure 13. *Sporobolus clandestinus* (a; Texas, Hays Co., *Harms 18* [TEX]) and *S. compositus* var. *macer* (b; Texas, Bastrop Co., *Harms 30* [TEX]) lemma surfaces at 100X. Both taxa show strongly sinuate long cells and pale, short and somewhat rounded silica cells regularly spaced among the long cells, larger and more prominent with *S. compositus*. *S. clandestinus* has abundant larger slightly oval dark cells — i.e., prickles, with the translucent prickle tip only barely visible at this magnification.

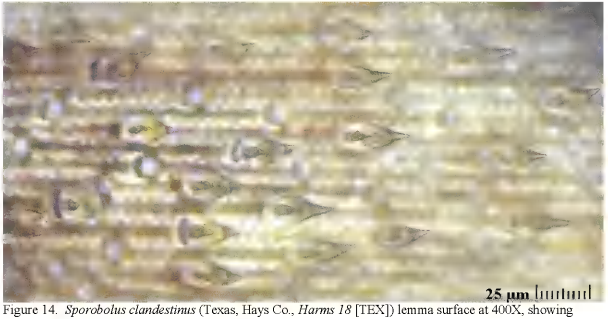


Figure 14. *Sporobolus clandestinus* (Texas, Hays Co., *Harms 18* [TEX]) lemma surface at 400X, showing prickles not on the same focal plane as the long cells and silica cells.

Figure 15. *Sporobolus compositus* var. *macer* (Texas, Bastrop Co., *Harms 30* [TEX]) lemma surface at 400X, showing long cells (L) and silica cells (S), but not prickles.

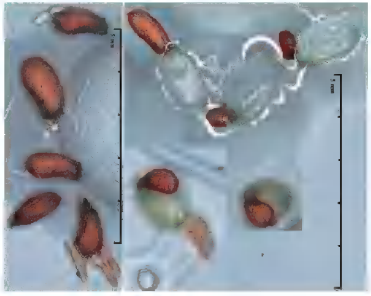


Figure 16. Wet separation of *S. compositus* var. *drummondii* pericarps. Dry grains on left; the same grains after 40 minutes in water.

Figure 17. Wet separation of *S. compositus* var. *compositus* after 2 hours (Colorado Co., *Carr 199691*).

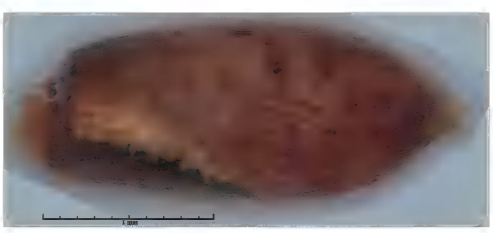


Figure 18. Pericarp of *S. clandestinus* after 36 minutes in water. It may appear gelatinous and somewhat loosened under high magnification (45X), but will not separate from the seed after prolonged immersion.

Figure 19. *Sporobolus compositus* var. *drummondii* habit, N. Hays Co., 6 October 2006.

Figure 20. *Sporobolus compositus* var. *drummondii* culm length > 42 inches, N. Hays Co., November 2002.

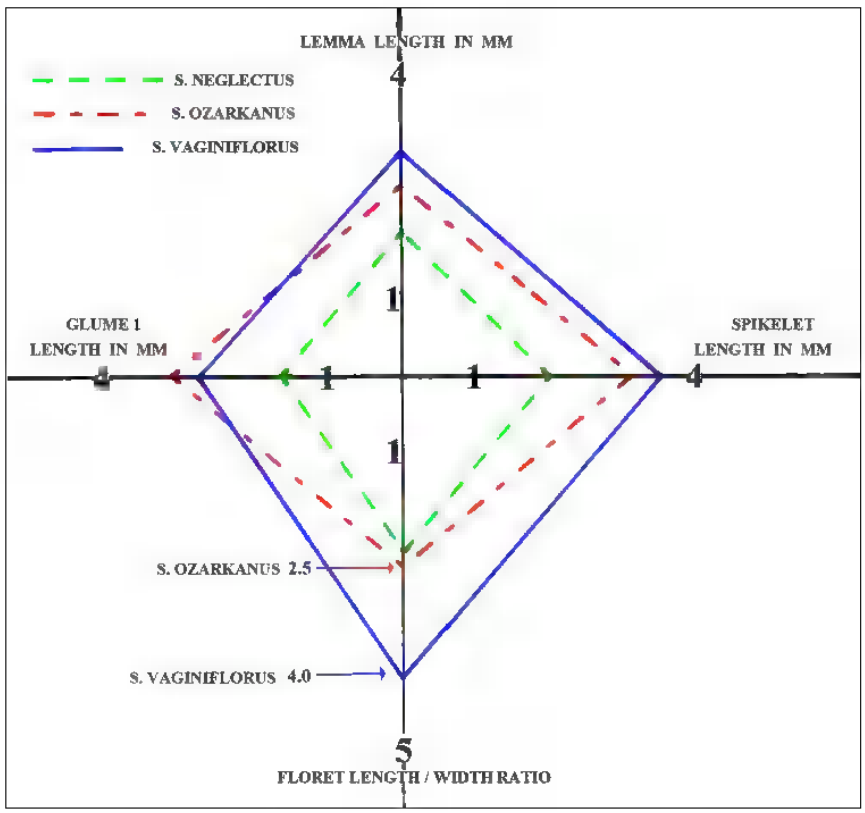


Figure 21. Variation of mean values of spikelet characters of *S. neglectus*, *S. ozarkanus* and *S. vaginiflorus*. (Adapted from Riggins 1969, Fig. 3.)

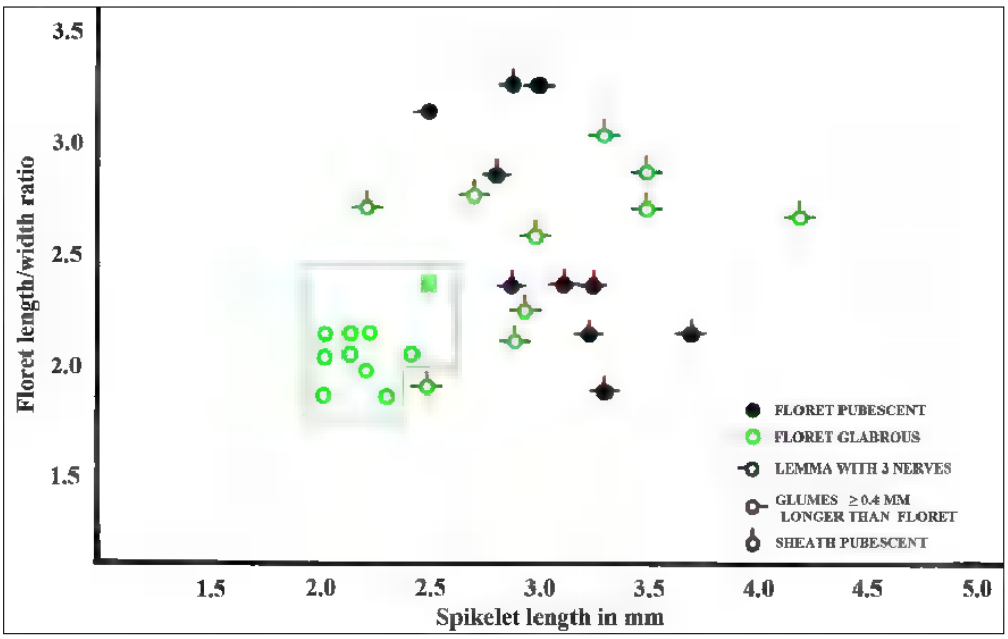
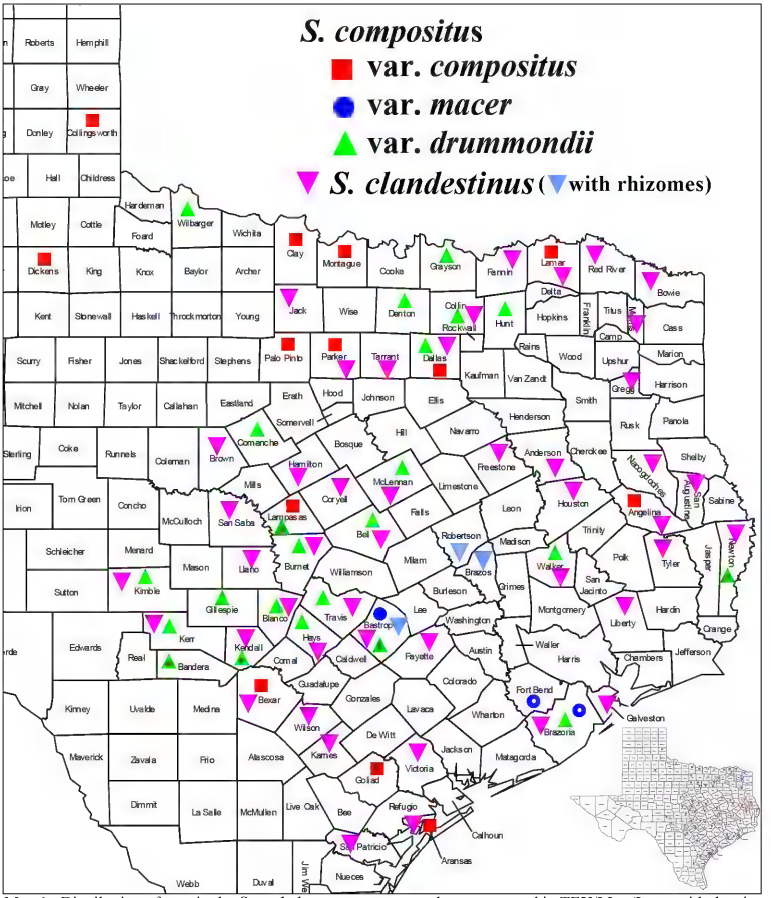
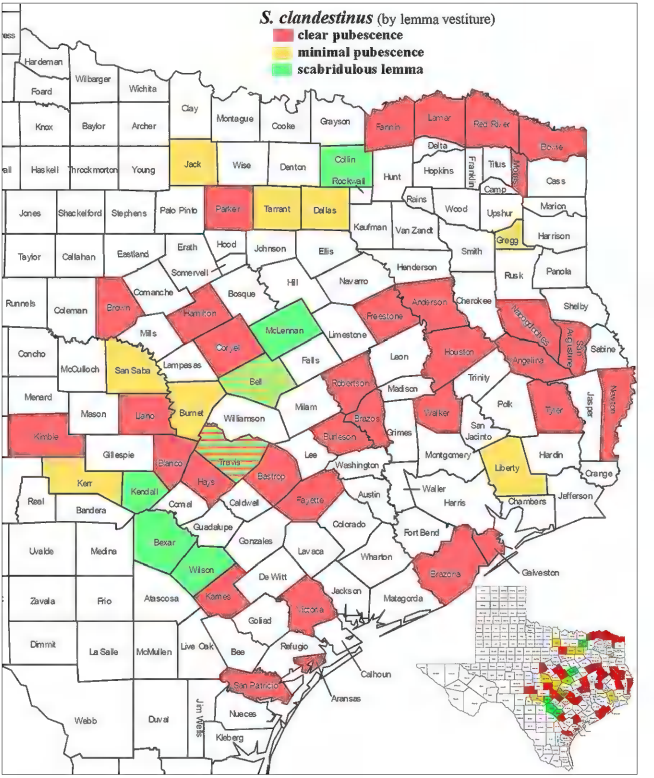


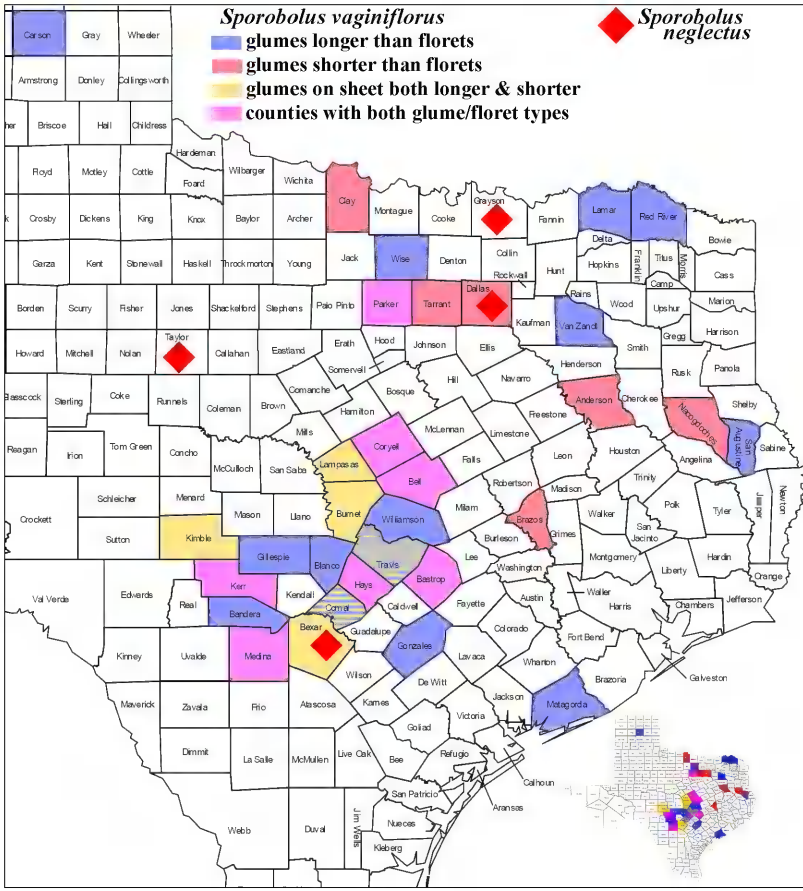
Figure 22. Scatter diagram of mass collection RLR 718, Jasper County, Missouri. *S. neglectus* in green box; *S. vaginiflorus*, purple box; rest are *S. ozarkanus*. (Adapted from Riggins 1969, Fig. 5.)



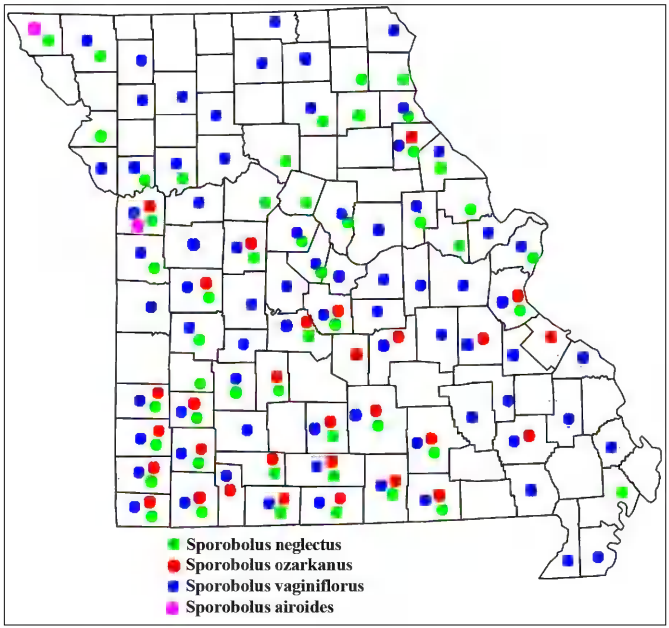
Map 1. Distribution of taxa in the *Sporobolus compositus* complex represented in TEX/LL. (Icons with dots in the center indicate collections not seen in 2002.)



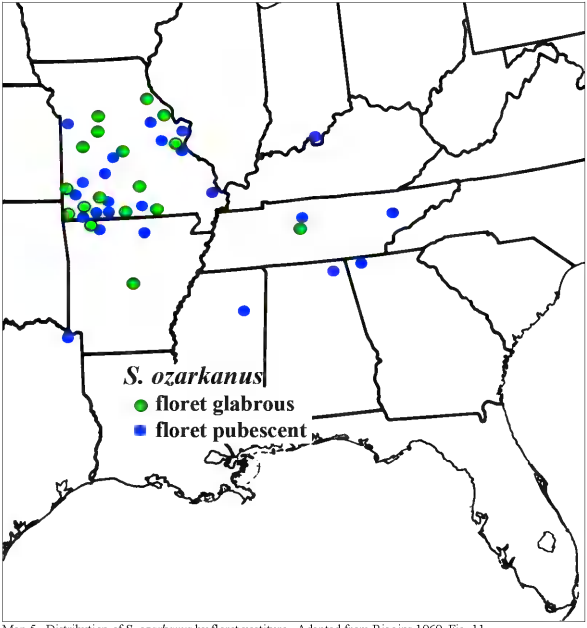
Map 2. Distribution of *Sporobolus clandestinus* lemma vestiture types.



Map 3. Distribution of *Sporobolus neglectus* and *S. vaginiflorus* (by relative glume/floret length) represented in TEX/LL.



Map 4. Distribution of *S. neglectus*, *S. ozarkanus*, *S. vaginiflorus*, and *S. airoides* in Missouri.



Map 5. Distribution of *S. ozarkanus* by floret vestiture. Adapted from Riggins 1969, Fig. 11.

Thomas, J.R. 2015. Revision of *Dichanthelium* sect. *Lanuginosa* (Poaceae). Phytoneuron 2015-50: 1–58. Published 21 September 2015. ISSN 2153 733X

REVISION OF *DICHANTHELIUM* SECT. *LANUGINOSA* (POACEAE)

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ABSTRACT

Debate and confusion have persisted regarding the morphological ranges and limits of those taxa found within *Dichanthelium* sect. *Lanuginosa*. Phenetic analysis, principal components analysis, and pair-wise t-tests of character states were conducted with 285 specimens using 32 morphological characters. An additional examination of 2780 herbarium specimens, including all relevant type material, resulted in the recognition of 16 species and one subspecies. Many of the entities currently subsumed within the *D. acuminatum* and *D. ovale* complexes are here interpreted to represent distinct species in terms of morphology. Many of these taxa were secondarily found to exhibit geographical and ecological distinctions, which are also discussed. All 160 names associated with the section are reviewed and an accurate nomenclature is applied to the group. *Dichanthelium lanuginosum* is reinstated as distinct from *D. acuminatum* and two new nomenclatural combinations are proposed: **Dichanthelium thermale** (Bol.) J. Thomas, **comb. nov.** and **Dichanthelium thermale** subsp. **sericeum** (Schmoll) J. Thomas, **comb. nov.**

Dichanthelium is one of the largest genera of New World grasses. Because of its diversity and wide distribution, a taxonomic understanding of the genus is vital to floristic treatments, monitoring projects, restoration efforts, and other areas of conservation and taxonomic concern. Hitchcock and Chase (1910) published *Dichanthelium* as a subgenus of *Panicum* to accommodate those taxa that produce terminal and axillary inflorescences (floral dimorphism), possess winter rosettes in addition to cauline leaves (foliar dimorphism), and rounded rather than pointed spikelets. This is in contrast to members of subg. *Panicum*, which only produce terminal inflorescences, lack winter rosettes, and generally have pointed spikelets. In addition to these differences, more contemporary studies have demonstrated further distinctions between *Dichanthelium* and *Panicum*. Brown (1948), Smith and Brown (1973), and Brown and Smith (1975) demonstrated that members of subg. *Dichanthelium* utilize C3 photosynthetic pathways as opposed to members of subg. *Panicum*, which are primarily C4 grasses. Boyle (1945) reported that subg. *Dichanthelium* has an extremely low incidence of polyploidy (only 3 out of approximately 100 species) whereas 70–80% of subg. *Panicum* species are polyploid. Brown et al. (1957) noted that subg. *Dichanthelium* has two layers of tunica cells in the shoot apices whereas subg. *Panicum* has a single layer.

Given the extent of such differences, Gould (1974) elevated subg. *Dichanthelium* to the rank of genus. However, some taxonomists have been hesitant to accept this status change, noting an abundance of tropical species that appear to be intermediate between the two genera (Lelong 1986; Webster 1988; Crins 1991; Gleason & Cronquist 1991; Yatskievych 1999). The argument against elevation of *Dichanthelium* to generic rank was further supported by Morrone and Zuloaga (1991) and Zuloaga et al. (1993a, b), who tested the evidence defending *Dichanthelium* as a distinct genus. Their results indicate intermediates and exceptions regarding foliar and floral dimorphism, ploidy level, and C3 versus C4 photosynthesis, especially in Central and South American species. More recent evidence has come from research involving the molecular phylogeny of Panicoideae (Giussani et al. 2001; Aliscioni et al. 2003; Morrone et al. 2008). These studies demonstrate that *Panicum s.l.* is polyphyletic unless *Dichanthelium*, among others, is treated as a separate genus. Additionally, many of the presumed intermediate taxa (most notably *Panicum* sect. *Cordovensia*) that were used to maintain *Dichanthelium* as a subgenus of *Panicum* have been shown to represent distinct lineages (Aliscioni et al. 2003; Morrone et al. 2008). Though debate may still be pertinent, the current tide of evidence seems to best support *Dichanthelium* as a distinct genus. The development of an over-

wintering rosette in this group of grasses may have led to the diversification of *Dichanthelium* into temperate North America (Morrone 1991; Zuloaga et al. 1993b) and this foliar dimorphism does offer a reasonable synapomorphy for the genus.

Dichanthelium includes 72–109 species (Gould & Clark 1978; Freckmann & Lelong 2003; Hitchcock & Chase 1910). Most are native to North America (Freckmann & Lelong 2003) but they are also found in South America and the Antilles. Members of the genus are perennials that have erect to decumbent stems that range from 5–150 cm long, vary greatly in degrees of pubescence, and often have short, wide leaves relative to other grasses. *Dichanthelium* species experience two flowering periods per growing season (Freckmann & Lelong 2003): a terminal paniculate inflorescence in spring followed by mid-summer inflorescences on axillary branches that bloom through autumn. The spikelets of the vernal inflorescences are reportedly chasmogamous, while those of the autumnal inflorescences are occasionally cleistogamous (Zuloaga et al. 1993b). The spikelets of *Dichanthelium* range from 0.8–5.2 mm in length and typically have morphologically dissimilar glumes, one sterile lemma, and a single fertile floret (Freckmann & Lelong 2003).

In 1910, Hitchcock and Chase arranged the taxa of what they treated as subg. *Dichanthelium* into 17 informal groups based on morphological characters. Many authors since have incorrectly used these names as subgenera, sections, or sub-sections, but only more recently have any groups been validly published as sections within *Dichanthelium* (Freckmann & Lelong 2002). In so doing, Freckmann and Lelong (2002) reduced the 17 informal groups of Hitchcock and Chase (1910, 1951) to 13 sections (*Angustifolia*, *Clandestina*, *Dichanthelium*, *Ensifolia*, *Lancearia*, *Lanuginosa*, *Linearifolia*, *Macrocarpa*, *Nudicaulia*, *Pedicellata*, *Oligosantha*, *Sphaerocarpa*, and *Strigosa*). The informal groups *Lanuginosa*, *Spreta*, and *Columbiana* of Hitchcock and Chase (1910, 1951) (Table 1) were all included in sect. *Lanuginosa* by the treatment of Freckmann and Lelong (2002). As defined by Freckmann and Lelong (2002), sect. *Lanuginosa* differs from other sections by the following combination of characters: vernal leaves distributed along the stem (not basally disposed), ciliate ligules ranging from 0.2 to 4.7 mm long, pubescent spikelets that are elliptical in outline, and primary glumes that are less than half the length of the spikelet.

According to Freckmann and Lelong (2003) sect. *Lanuginosa* comprises 3 North American species and 12 subspecies. This is a significant reduction in the number of taxa from the treatment of Hitchcock and Chase (1910, 1951), who recognized 33 species and 2 varieties (Table 1). Without discussion, Gould and Clark (1978) recognized 3 species and 9 varieties within what is now sect. *Lanuginosa* (Table 1). Many regional treatments (Braun 1967; Freckmann 1981; Gleason & Cronquist 1991; Hansen & Wunderlin 1988; Lelong 1984; Mohlenbrock 1986; Radford et al. 1968; Steyermark 1963; Strausbaugh & Core 1978; Swink & Wilhelm 1994; Voss 1972; Weishaupt 1968) appear to reflect Fernald's (1934, 1950) conservative treatments of those taxa occurring in northeastern North America. However, confusion and frustration still persist regarding the regional application of delineated taxa within the section.

It has been noted (Freckmann 1981; Gould & Clark 1978; Hansen & Wunderlin 1988; Swink & Wilhelm 1994; Voss & Reznicek 2012; Yatskievych 1999) that in order to understand the species complexes within *Dichanthelium*, detailed morphological and population-level studies will be necessary. Though Shinners (1944) conducted an informal investigation into the "empirically existing discontinuities" of a few taxa within sect. *Lanuginosa*, a thorough analysis of the morphological diversity has never been published. Due to the enthusiasm with which late 19th Century botanists described the variation in sect. *Lanuginosa*, an abundance of subsequent treatments attempting to render regional clarity and the subsumption of many regional taxa by modern treatments, we are left with a convoluted history of splitting and lumping of sections, species, subspecies, and varieties, often with little or no justification. The taxonomic confusion of the section appears to rests on the widely varying emphasis of ligule, pubescence, and spikelet characters. The primary goals of the present study are to (1) statistically investigate the morphological variation

within sect. *Lanuginosa* in order to elucidate the natural boundaries of the taxa within, (2) review all available literature and type material in order to provide and apply an accurate nomenclature, (3) test the results of the data analysis against specimens from throughout the geographic range of the section, and (4) investigate and report the ecological and geographical context of each taxon.

Hitchcock and Chase, 1910	**Gould and Clark, 1978**	**Freckmann and Lelong, 2003**
Group *Columbiana*	No subgeneric rank given	Section *Lanuginosa*
Panicum addisonii	*D. sabulorum* var. *patulum*	*Dichanthelium acuminatum*
P. columbianum	var. *thinium*	subsp. *acuminatum*
var. *columbianum*	*D. ovale* var. *ovale*	subsp. *columbianum*
var. *thinium*	var. *addisonii*	subsp. *fasciculatum*
P. commonsianum	*D. acuminatum* var. *acuminatum*	subsp. *implicatum*
P. malacon	var. *densiflorum*	subsp. *leucothrix*
P. oricola	var. *implicatum*	subsp. *lindheimeri*
P. tsugetorum	var. *lindheimeri*	subsp. *longiligulatum*
P. wilmingtonense	var. *longiligulatum*	subsp. *sericeum*
	var. *thurowii*	subsp. *spretum*
Group *Lanuginosa*	var. *villosum*	subsp. *thermale*
P. acuminatum	var. *wrightianum*	*D. ovale* subsp. *ovale*
P. albemarlense		subsp. *praecocius*
P. auburne		subsp. *pseudopubescens*
P. huachucae var. *huachucae*		subsp. *villosissimum*
var. *silvicola*		*D. wrightianum*
P. implicatum		
P. languidum		
P. lanuginosum		
P. meridionale		
P. occidentale		
P. olivaceum		
P. ovale		
P. pacificum		
P. praecocius		
P. pseudopubescens		
P. scoparioides		
P. shastense		
P. subvillosum		
P. tennesseense		
P. thermale		
P. thurowii		
P. villosissimum		
Group *Spreta*		
P. leucothrix		
P. lindheimeri		
P. longiligulatum		
P. spretum		
P. wrightianum		

Table 1. Summary of past taxonomic treatments for all taxa involved in sect. *Lanuginosa*.

METHODS

A total of 2780 specimens, including type specimens, from throughout the geographical range of sect. *Lanuginosa* was examined from several herbaria (F, GH, MIN, MO, MU, NCU, NY, URV, US, WIS, WS). From these, a subset of specimens representing the morphological and geographical range of sect. *Lanuginosa* was compiled. Specimens that lacked ample fertile or vegetative material for sampling were not included in the data set. These specimens were sampled for 104 vegetative characters and 12 floral characters. These data were then analyzed via histograms (Appendix B) and an analysis of character means in order to eliminate any characters that were invariant or unimodal throughout the data set. This was largely done to reduce the number of measured characters and thereby increase the number of specimens that could be sampled during the time frame of the study. Using the remaining 32 characters (Table 2), 285 specimens were sampled. All type specimens that possessed sufficient characters were included in the sampling. In order to further maximize efficiency and focus on the confusing morphological complexes in the section, more specimens were sampled from the notoriously problematic "morpho-groups" than from the more obviously distinct ones. For example, all previous treatments have maintained *Dichanthelium wrightianum* as a morphologically distinct taxon, therefore few specimens, only later associated with this name, were sampled for what could be interpreted as this morphology.

The data were entered into Microsoft Excel and imported into NT-SYS-pc 2.1 (Rohlf 2002) for analysis. In NT-SYS, the data were standardized, a similarity matrix was created, distance coefficients were computed and a phenogram was constructed by the sequential, agglomerative, hierarchical, and nested clustering method (SAHN) using the unweighted pair group method with arithmetic mean (UPGMA). This analysis resulted in a phenogram with two distinct clusters. The two clusters are here referred to as the Long Ligule Group and the Short Ligule Group. In order to more thoroughly and adequately investigate the significance of the morphological variation in the analysis as well as elucidate the morphological characters of taxonomic importance, the data were divided into these two groups and analyzed independently for the remainder of the analysis. It is important to note that this investigation is in no way an attempt to portray the evolutionary relationships within sect. *Lanuginosa*, nor is this analysis in accordance with the practices of numerical taxonomy. Rather, the main objective of this portion of the analysis is to remove as many constant, invariant, and unimodal variables as possible in order to empirically explain the different morphologies within the section and later test the strength of these differences via principal components analysis and other statistical methodologies outlined below. Splitting the data into two sets, a step justified by the SAHN clustering analysis, is one way to accomplish this.

Once the data were split into the Long Ligule Group and the Short Ligule Group, based primarily on the influence of ligule length in the SAHN cluster analysis, invariant characters were eliminated from each group, leaving 24 characters (Table 2) for the 142 specimens within the Long Ligule group and 12 characters (Table 2) for the 143 specimens within the Short Ligule group. Each of the two independent data sets was then reanalyzed by the SAHN clustering methodology above as well as by principal components analysis (PCA). All data in the PCA were standardized so that each character had an equal contribution to the variance in the analysis. The clusters of specimens generated by the SAHN cluster analysis and PCA were evaluated for similarity and consistency. Each of the resultant clusters was then analyzed by pair-wise comparisons, using two sample T-tests, in order to investigate the significance of the differences between clusters for each character. An additional PCA was conducted in order to further investigate the morphological variance of two slightly overlapping clusters in the Long Ligule Group — namely, those of *D. lanuginosum* and *D. implicatum*.

	Character	Abbreviation	Character State
1.	ligule pubescence maximum length	LigLen*‡	(mm)
2.	ligule trichome uniformity	LigTriUni*	0=no; 1=yes
3.	mid-stem sheath pubescence maximum length	MidShePubMax*	(mm)
4.	mid-stem sheath glabrous to glabrate	MidSheGla*	0=no; 1=yes
5.	mid-stem leaf adaxial pubescence maximum length	AdaLeaPubMax*	(mm)
6.	adaxial surface of mid-stem leaf glabrous to glabrate	AdaSurMidLeaGla*	0=no; 1=yes
7.	terminal sheath pubescence maximum length	TerShePubMax*	(mm)
8.	terminal sheath glabrous to glabrate	TerSheGla*	0=no; 1=yes
9.	terminal leaf abaxial pubescence minimum length	TerLeaAbaPubMin*	(mm)
10.	terminal leaf abaxial pubescence maximum length	TerLeaAbaPubMax*	(mm)
11.	spikelet length	SpiLen*‡	(mm)
12.	spikelet width	SpiWid*	(mm)
13.	first glume length	PriGluLen*‡	(mm)
14.	longest leaf length	LonLeaLen*	(mm)
15.	longest leaf width	LonLeaWid*‡	(mm)
16.	number of nodes in inflorescence	NumInfNod*	number
17.	inflorescence axis with puberulent pubescence	PubPubInf*	0=no; 1=yes
18.	peduncle glabrous to glabrate	PedGla*	0=no; 1=yes
19.	peduncle pubescence double invested	PedPubDou*	(mm)
20.	abaxial leaf surfaces with puberulent pubescence	AbaLeaSurPub*	0=no; 1=yes
21.	inflorescence < a third as long as wide	InfNar*	0=no; 1=yes
22.	fertile floret pointed	FerFloPoi*	0=no; 1=yes
23.	inflorescende w/ double vestiture	InfDouVes*	0=no; 1=yes
24.	spikelet pointed at apex	SpiPoi*	0=no; 1=yes
25.	double ligule conspicuous	DouLigCon‡	0=no; 1=yes
26.	double vestiture on culm	DouVes‡	0=no; 1=yes
27.	number of trichomes across mid-stem adaxial leaf surface	NumTriAdaLeaSur‡	number
28.	mid-stem leaf glabrous along middle of adaxial surface	MidLeaGlaAda‡	0=no; 1=yes
29.	terminal leaf glabrous along middle of adaxial surface	TerLeaGlaAda‡	0=no; 1=yes
30.	mid-stem sheath indument length	MidSheIndLen‡	(mm)
31.	sheath pubescence orientation	ShePubOri‡	scale; 0=appressed; 1=erect
32.	mid-stem leaf marginal cilia >30	Cilia>30‡	0=no; 1=yes

Table 2. Morphological characters used in the final phenetic analysis and principal components analysis. "*" indicates characters pertaining to the Long Ligule Group. "‡" indicates characters pertaining to the Short Ligule Group.

Based on the results of these analyses, preliminary groups and their defining morphological limits were determined. The range of character variability found in the data was then analyzed for consistency by testing the results against an additional 458 herbarium specimens from 33 states, 7 Canadian provinces, 4 Central American countries, and 3 Caribbean islands. A review of the literature and type specimens involved in sect. *Lanuginosa* was conducted in order to determine the appropriate application of nomenclature within the clusters generated in the data analysis. Once an accurate nomenclature was determined, a key was constructed from the data collected in the analysis and all 2780 specimens from the original compilation were examined, sorted, and annotated. Throughout the annotation process, detailed notes regarding the regional variation of each taxon and trait were taken. Distribution maps were compiled from the information provided on the herbarium labels of each specimen. Habitat information for each taxon was determined from the label information, previous treatments (where applicable), and from the author's 17 years of extensive field experience with the group.

RESULTS

Of the 116 morphological characters sampled using histogram and mean analysis, 32 proved informative. The SAHN cluster analysis of all 285 specimens for all 32 characters resulted in an obvious split of the data set into two major groups (Figure 1), here referred to as the Long Ligule Group and the Short Ligule Group. A review of all the characters in the analysis revealed that the length and distribution of ligule hairs were largely responsible for the division of the specimens into these two groups (Figure 2). The Long Ligule Group consistently possesses a uniformly long ligule pubescence that is indistinguishable from the pseudoligule, whenever present, and is always 1.7 mm long or longer. The Short Ligule Group primarily possesses a short ligule that is often, but not always, subtended by a longer pseudoligule. When the pseudoligule is short or intermeshed with the ligule, the ligule is often difficult to discern. In such cases, teasing the ligule with a probe revealed that the first row of ligule hairs was always 1.5 mm long or shorter. Given the strength of the split, its alignment with past treatments in which ligule length has always been a primary character, and in order to more precisely investigate the statistical variation in morphology within the section, each of these two groups were analyzed independently for the remainder of the study. Twenty of the 32 sampled characters were unique to the Long Ligule Group, 8 were unique to the Short Ligule Group and 4 were common to both groups (Table 2).

The independent SAHN cluster analyses of both the Long Ligule Group (Figure 3) and the Short Ligule Group (Figure 4) resulted in several clusters each. However, the degree to which these clusters represented discrete morpho-taxa was not apparent. A comparison of these results with those of the clusters derived from the PCA of each group (Figures 5 and 6), in conjunction with where the type specimens sorted within the clusters were ultimately used to elucidate the morpho-taxa represented in the data. Based on these results, the Long Ligule Group consisted of ten clusters and the Short Ligule Group consisted of seven clusters.

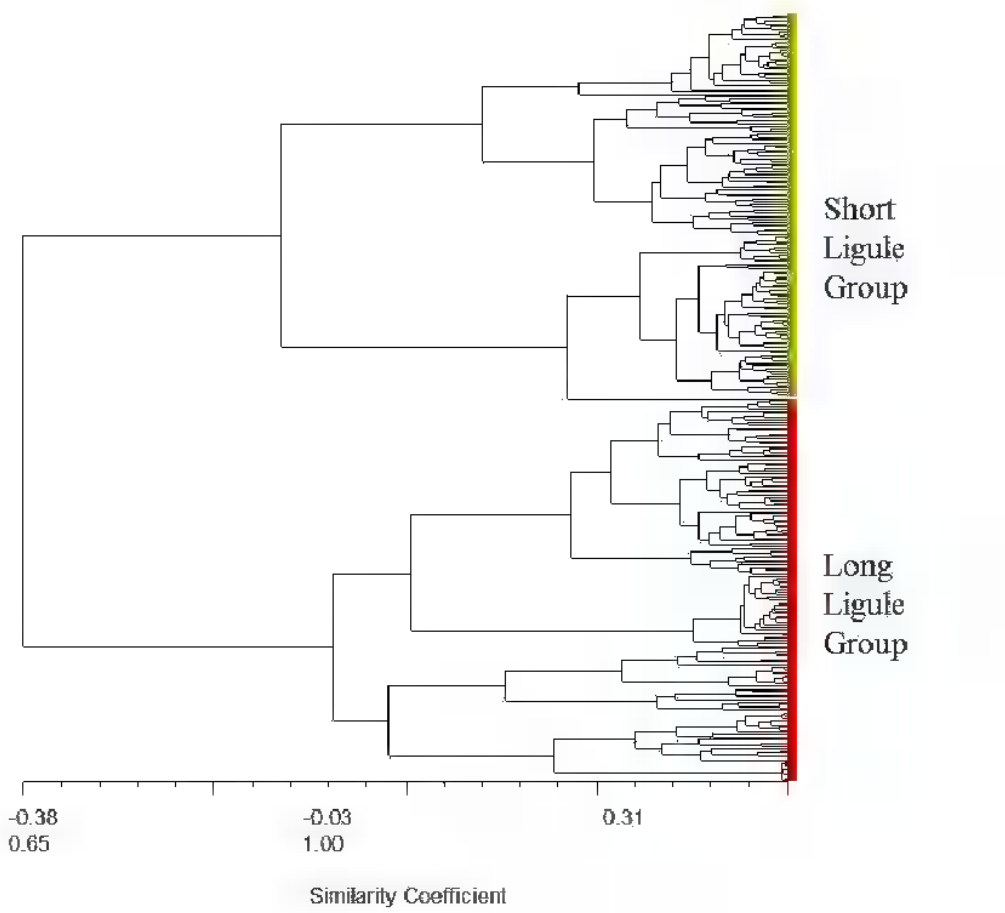


Figure 1. Phenogram for all 285 OTUs using 32 morphological characters. Cophenetic correlation coefficient (r) = 0.85.

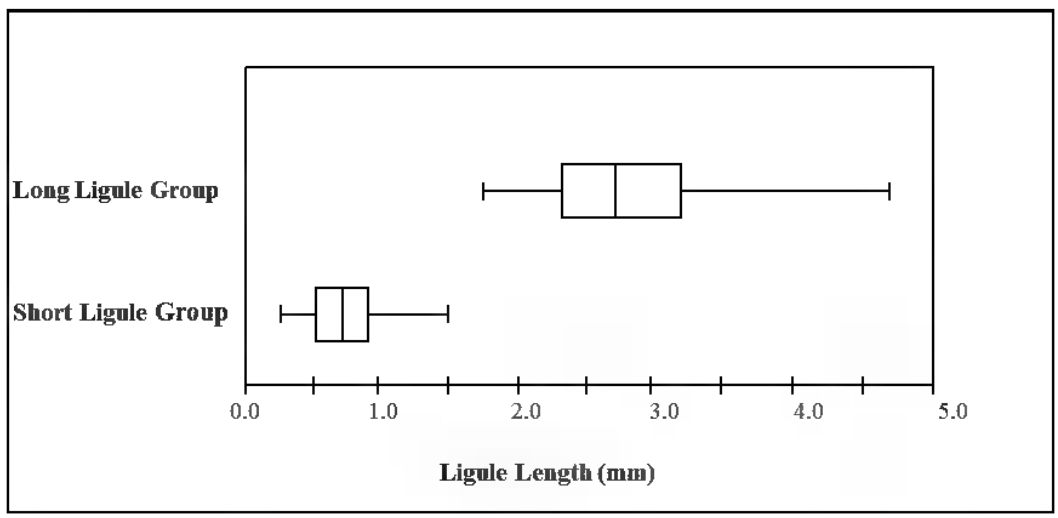


Figure 2. Box plot showing the lack of overlap in ligule length between the OTUs of the Long Ligule and Short Ligule groups.

In order to further investigate the strength of the clusters derived from the SAHN cluster analysis and PCA and to thereby assist in the assignment taxonomic ranks, pair-wise comparisons of each cluster for each character using two sample t-tests were conducted. The Long Ligule Group showed a significant difference of $P \leq 0.05$ for no less than nine and as many as 22 of the 24 characters sampled (Table 3). A significant difference of $P \leq 0.005$ was found for no less than four and as many as 20 of the characters (Table 3). For the Short Ligule Group, the two sample t-tests showed a significant difference of $P \leq 0.05$ for no less than four and as many as 11 of the 12 characters (Table 4). A significant difference of $P \leq 0.005$ was found for no less than three and as many as 11 characters (Table 4).

Within the Long Ligule Group, the first three principal component axes of the PCA accounted for 72 percent of the variation (Table 5). Nine clusters were separated by the first two principal component axes (Figure 5). Characters involving the length and density of pubescence along leaves and sheaths, as well as spikelet characters, contributed the most variation along the first principal component (PC1). Leaf length and characters involving the pubescence of the inflorescence contributed most to the variation along the second principle component (PC2).

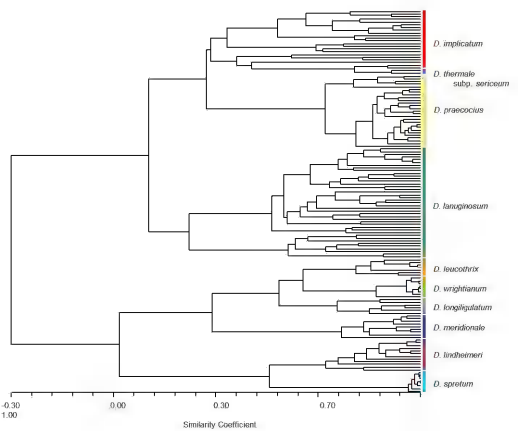


Figure 3. Phenogram of the Long Ligule Group based on 142 OTUs and 24 morphological characters. Cophenetic correlation coefficient (r) = 0.91.

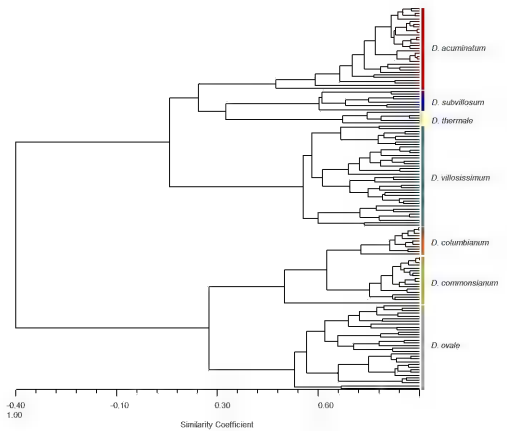


Figure 4. Phenogram of the Short Ligule Group based on 143 OTUs and 12 morphological characters. Cophenetic correlation coefficient (r) = 0.90.

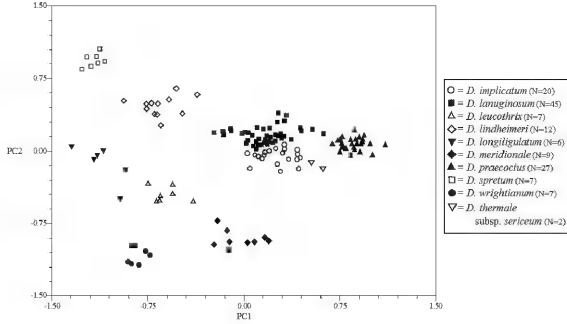


Figure 5. Scatter plot of the scores of principal component 1 (PC1) and principal component 2 (PC2) for all the standardized morphological characters of 142 specimens in the Long Ligule Group.

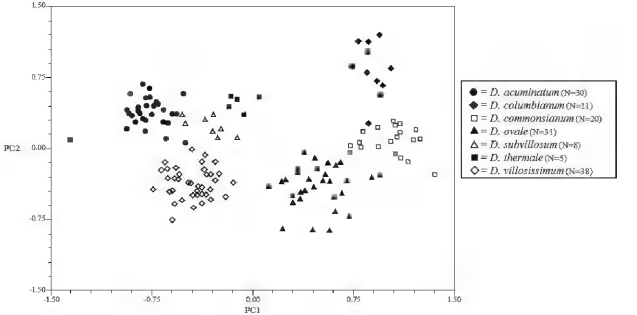


Figure 6. Scatter plot of the scores of principal component 1 (PC1) and principal component 2 (PC2) for all the standardized morphological characters of the 143 specimens in the Short Ligule Group.

	D. wrightianum	*D. spretum*	*D. meridionale*	*D. longiligulatum*	*D. leucothrix*	*D. implicatum*	*D. praecocius*	*D. lindheimeri*
D. lanuginosum	1,2,5,7,10,11,12, 13,14,**15,16**,17, 19,20,22,23	1,2,4,5,6,7,8,9, 10,**12**,15,16,18, 21,22,24	**1,2,3,5,10**,11, **13**,14,15,16,17, 19,20,23	**1,**4,5,6,7,**8,9**, 10,11,12,**13**,14,15, 17,18,**19**,20,22,23	**1,**2,3,**4,5**,6, 7,10,11,12,**13**, 14,15,20,22,23	**5,6**,7,9,10, **11,12**,14, **15,16**	2,3,5,6,7,9, 10,11,12,13, 14,15,16,17	1,2,3,4,5,6, 7,8,9,10,**11**, 13,14,**15**
D. lindheimeri	2,4,6,7,8,9,10, 11,12,**13**,14,15, 17,18,19,20,22,23	**1,2,11,13,15**, 16,21,22,24	3,4,5,6,7,8,9,10, 13,14,15,**16**,17, 18,19,20,23	2,9,10,**11**,12, 14,15,20,22,23	4,7,8,9,10,11, 12,14,**15**,18, 20,22,23	**1**,2,3,4,5, 6,7,8,9,10, **13**,14,18	2,3,4,5,6,7, 8,9,10,11,12, 13,16,17,18	
D. praecocius	**1,**2,3,5,7,9,10, 11,12,13,14,15, 16,17,19,20,22,23	**1,**2,3,4,5,6,7,8, 9,10,11,12,13,**14**, 16,17,18,21,22,2 4	2,3,**5,7,9,10**,11, 12,13,14,15,16, 19,20,23	2,3,4,5,6,7,8,9,10, 11,12,13,14,15,16, 17,18,**19**,20,22,23	2,3,**4,5**,6,7,9,10, 11,12,13,14,**15**, 16,17,20,22,23	2,3,5,7,9, **10**,11,12, 13,14,16,17		
D. implicatum	**1,**3,5,7,9,10,11, 12,13,14,**15**,17, 19,20,22,23	1,3,4,5,6,7,8,9, 10,14,16,18,21, 22,24	2,**10**,13,**14**,15, **16**,17,19,20,23	3,4,5,6,7,8,9,10,**11**, 12,**13**,**15**,17,18, **19**,20,22,23	2,3,5,6,7,9,10, 11,12,14,20,22, 23			
D. leucothrix	2,3,6,7,11,12, 13,**14**,17,19	1,2,3,4,5,7,8,9,10 11,12,**13**,14,16, 18,20,21,23,24	3,5,6,10,11,12,13, **15**,16,17,19,22	2,3,4,5,7,8,9, **10,18**				
D. longiligulatum	3,4,6,7,8,9,**10**, 11,12,**13**,**14**,**17**, 18,19	**1,9,10**,11, **13**,14,**15**,20, 21,23,24	3,4,5,6,7,8,9,10, **11,12**,13,**16**,17, 18,19,22					
D. meridionale	2,3,5,7,10,11, 12,13,14,17,22	1,2,3,4,5,6,7,8,9, 10,**11**,14,15,16, 17,18,19,20,21, 22,23,24						
D. spretum	3,4,6,7,8,9,10,11, 12,13,14,**15**,16,17, 18,19,20,21,23,24							

Table 3. Results of pair-wise comparisons of Long Ligule Group using two sample t-tests. Numbers correspond to characters listed on Table 2. The numbers not in bold are those characters that demonstrate a significant difference of $P \leq 0.005$. Bold numbers are those characters that demonstrate P-values between 0.05 and 0.005.

	D. villosissimum	*D. thermale*	*D. subvillosum*	*D. ovale*	*D. commonsianum*	*D. columbianum*
D. acuminatum	**1**,11,13,30,31,32	13,25,26,31,32	**1**,13,15,**25**,26, **30**,31,32	1,11,13,26,27, 28,29,30,31,32	**1**,11,13,15,25, 26,27,28,29,31,32	1,13,15,25,26,27, 28,29,30, 31,32
D. columbianum	1,11,**13**,15,25,26, 27,28, 29,30,31	1,15,26,27,28,29,31	1,25,26,27,28, 29,30,31	1,11,13,15,25, 26,27,30,**31**	1,11,13,**27**,**30**	
D. commonsianum	1,11,13,15,25,26, 27,28, 29,30,31	11,13,15,26,27, 28,29,31	11,13,25,26,27, 28,29,31	1,13,15,25,26,**27**		
D. ovale	**1**,11,13,26,27,28, 29,30, 31	1,11,13,25, 26, 27,28,29,**30**,**31**	1,11,13,**15**,**25**,27, 28,29,**31**			
D. subvillosum	1,11,**15**,**25**,26,30	**15**,25,26,30				
D. thermale	1,11,25,26,30					

Table 4. Results of pair-wise comparisons of Short Ligule Group using two sample t-tests. Numbers correspond to characters listed on Table 2. The numbers not in bold are those characters that demonstrate a significant difference of $P \leq 0.005$. Bold numbers are those characters that demonstrate P-values between 0.05 and 0.005.

Variable	PC1	PC2	PC3
(1) LigLen	0.470134	0.013531	0.311942
(2) LigTriUni	0.367315	-0.044885	**-0.638994**
(3) MidShePubMax	**0.929179**	-0.051885	-0.166881
(4) MidSheGla	**-0.702810**	0.446930	-0.314728
(5) AdaLeaPubMax	**0.841107**	-0.131279	-0.102921
(6) AdaSurMidLeaGla	**-0.689265**	0.401993	-0.077478
(7) TerShePubMax	**0.882629**	0.027453	-0.135609
(8) TerSheGla	**-0.695017**	0.492033	-0.297461
(9) TerLeaAbaPubMin	**0.805324**	-0.174873	-0.234322
(10) TerLeaAbaPubMax	**0.852446**	-0.105936	-0.103876
(11) SpiLen	**0.653451**	0.549536	-0.320496
(12) SpiWid	**0.690557**	0.413550	-0.300294
(13) PriGluLen	**0.677986**	0.142037	-0.575833
(14) LonLeaLen	0.295223	**0.698455**	0.188139
(15) LonLeaWid	0.302144	0.469000	0.541051
(16) NumInfNod	-0.519752	0.389019	0.330314
(17) PubPubInf	-0.195249	**-0.727720**	-0.244033
(18) PedGla	**-0.651382**	0.533550	-0.295013
(19) PedPubDou	-0.271396	**-0.774095**	-0.179592
(20) AbaLeaSurPub	-0.496088	**-0.771455**	-0.188159
(21) InfNar	-0.455718	0.503179	-0.397369
(22) FerFloPoi	**-0.770360**	-0.162314	-0.227806
(23) InfDouVes	-0.471496	**-0.781279**	-0.181547
(24) SpiPoi	-0.455718	0.503179	-0.397369
total variance explained	39.8226%	20.1040%	11.6452%
eigenvalues	9.5574	4.8249	2.7948

Table 5. Loadings for the first three principal components from the PCA of the Long Ligule Group. Bold numbers are characters greater than 0.60 (absolute value).

Because what would be determined to be *Dichanthelium lanuginosum* and *D. implicatum* appeared to form two very close clusters with marginal overlap along PC1 and PC2 (Figure 5), a PCA of the data for just these two clusters was conducted in order to further focus on how morphologically similar or dissimilar they are to one another (Figure 7). T-tests for these two clusters demonstrated that *Dichanthelium lanuginosum* differs significantly ($P \leq 0.05$) from *D. implicatum* by 10 of the 24 characters sampled (Table 3). According to the t-tests, maximum leaf length, maximum leaf width and the length of pubescence on the abaxial surface of the terminal vernal leaf are the strongest characters separating *D. lanuginosum* and *D. implicatum*. The scatter plot of the first and second principal components (Fig. 7) demonstrate little overlap between these two taxa.

Within the Short Ligule Group, the first three principal component axes of the PCA accounted for 78 percent of the variation (Table 6). The first two principal component axes demonstrate seven clusters (Fig. 6). Distribution, orientation and density of pubescence, as well as glume length and characteristics of the ligule contributed the most variation along the first principal component. Ligule length and spikelet length contributed to the most variation along the second principal component.

Each cluster from the results of the SAHN cluster analyses and the PCAs of the Long Ligule and Short Ligule groups contained one or more type specimens. The taxonomic ranks and nomenclature applied in this treatment are based on the data analysis above, the type specimens contained within each cluster, the published descriptions of type specimens and comparison of those types not complete enough to be included in the general sampling. This followed a thorough review of all 160 published names and type specimens directly associated with these taxa as well as a comparison of the morphological limits derived from the data with 458 additional herbarium specimens from 33 states, 7 Canadian provinces, 4 Central American countries and 3 Caribbean islands. From these results, 16 species and one subspecies were found to best represent the morphological diversity found within sect. *Lanuginosa*. Lastly, a dichotomous key utilizing the strongest characters in the analysis was constructed. The key was found to efficiently differentiate the taxa when tested against the original 2780 herbarium specimens from throughout the range of sect. *Lanuginosa*.

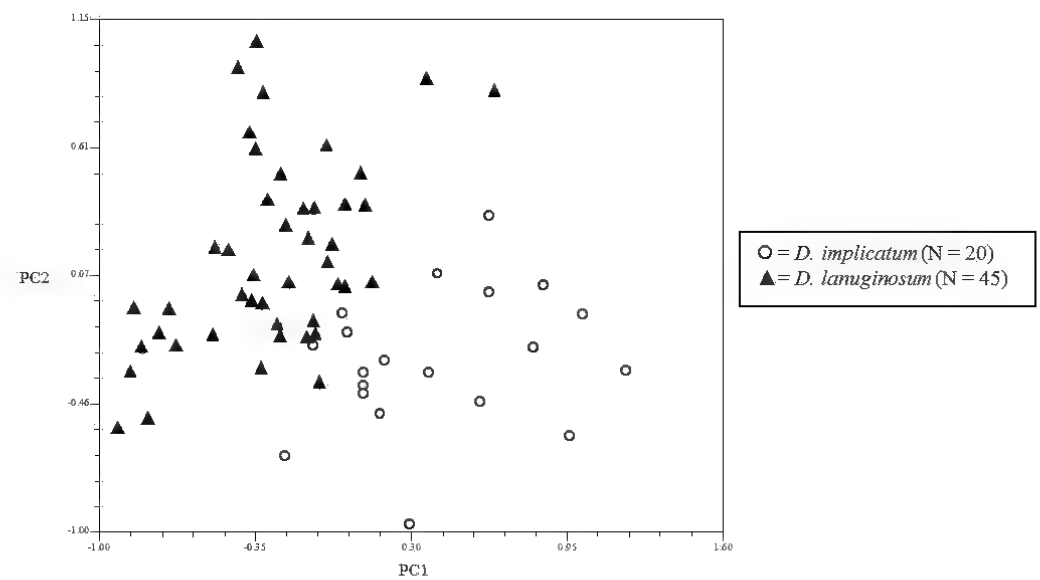


Figure 7. Scatter plots of the scores of principal component 1 (PC1) and principal component 2 (PC2) from PCA of *Dichanthelium implicatum* and *D. lanuginosum* specimens.

Variable	PC1	PC2	PC3
(1) LigLen	0.178984	**0.733770**	0.409249
(11) SpiLen	0.551986	**-0.754718**	-0.028215
(13) PriGluLen	**0.717599**	-0.486356	0.150821
(15) LonLeaWid	-0.501936	-0.259084	-0.311542
(25) DouLigCon	**0.670133**	0.481666	0.334808
(26) DouVes	**0.825638**	0.385092	0.202818
(27) NumTriAdaLeaSur	**-0.757211**	-0.061297	0.413394
(28) MidLeaGlaAda	**0.915842**	-0.061084	-0.259726
(29) TerLeaGlaAda	**0.915842**	-0.061084	-0.259726
(30) MidSheIndLen	-0.279299	**-0.648330**	0.569073
(31) ShePubOri	**-0.839872**	-0.016393	0.045759
(32) Cilia>30	-0.593963	0.447627	-0.458003
total variance explained	46.8454%	20.2014%	10.6903%
eigenvalues	5.6214	2.4241	1.2828

Table 6. Loadings for the first three principal components from the PCA of the Short Ligule Group. Bold numbers are characters greater than 0.60 (absolute value).

DISCUSSION

Based on the results of the SAHN cluster analyses, PCAs, the significance of each character in pairwise comparisons via t-tests, a complete review of the pertinent nomenclature, inclusion and review of the type specimens, and testing the assigned clusters against 2780 herbarium specimens from throughout the range of the group, sect. *Lanuginosa* is demonstrated to consist of at least 16 distinct species and one subspecies. Furthermore, based on herbarium label information, information provided in regional treatments, known phytogeographical trends, and the author's personal field experience, these taxa also prove to be ecologically and biogeographically satisfying.

While most of these taxa have recently been treated as subspecies or subsumed into synonymy, the entity level combinations of morphological, ecological, and geographical information provided here are interpreted as being more significant than can be justified by subspecific ranks. For example, the statistically distinct morphology expressed in what is here treated as *Dichanthelium praecocius* (*D. ovale* subsp. *praecocius* of Freckmann & Lelong 2003) is restricted to high quality prairie remnants within the Tallgrass Prairie Ecoregion while the statistically distinct morphology of what is here called *D. ovale* refers to an obligate acidophile restricted to the southeastern coastal plain of North America and the Antilles (see notes under *D. ovale* for a detailed discussion of the morphological differences in these taxa). Likewise, the morphological, ecological, and geographical distinctions of *D. thermale*, which only occurs along thermal springs of the Cascade and Rocky Mountains, provide more than sufficient evidence for recognizing *D. thermale* as a species as opposed to a subspecies (as in Freckmann & Lelong 2003) or synonym (as in Gould & Clark 1978) of *D. acuminatum*. Similar arguments are made under the notes section of each taxon.

While the splitting of the data into the Long Ligule Group and the Short Ligule Group was justified by the data analysis (Figures 1 and 2), it is important to note that it is also well in line with the interpretation and emphasis on ligule characters in several past treatments (Gould & Clark 1978; Hansen & Wunderlin 1988; Hitchcock & Chase 1910, 1951; Pohl 1947; Stone 1911). This split often correlates with the presence or absence of a distinct pseudoligule. Most members of the Long Ligule Group do not possess a distinct pseudoligule and many of the members of the Short Ligule Group possess a pseudoligule that is longer than the ligule. The exception to this occurs in glabrate forms of *Dichanthelium columbianum* and *D. ovale* (Short Ligule Group) where the lack of pubescence on the

adaxial leaf surfaces correlates to the lack of a pseudoligule. The ligule length character was also used in the treatments of Hitchcock and Chase (1910, 1951) as a major division between taxa in what is now considered section *Lanuginosa* such that the Long Ligule Group well represents most of the taxa included in the informal groups *Lanuginosa* and *Spreta* and the Short Ligule Group represents all members of *Columbiana* and a few members of *Lanuginosa*. It is also interesting that the geographical distributions of all members of the Long Ligule Group (minus the *Spreta* complex of Hitchcock and Chase which included what is here treated as *D. spretum*, *D. longiligulatum*, *D. leucothrix* and *D. wrightianum*) are mid-continental species that are largely absent from the coastal plain of southeastern USA while the Short Ligule Group and Hitchcock and Chase's *Spreta* are predominantly coastal plain species; most of which also range into the Antilles, Central America and northern South America. Furthermore, *Dichanthelium ovale*, *D. columbianum,* and *D. commonsianum*, the contemporary members of Hitchcock and Chase's *Columbiana*, are the only taxa to exhibit a restriction of pubescence to near the margins of the adaxial surfaces of vernal leaves (central portions glabrate). They also exhibit a double vestiture along vernal sheaths with puberulent pubescence often below a pilose or villose pubescence and ligules that are usually composed of intermeshed hairs of varying length. Given these morphological patterns and geographical affinities, further research investigating these trends within sect. *Lanuginosa* may find more credence in elevating the three informal groups recognized by Hitchcock and Chase to sectional status than maintaining the current, somewhat cumbersome, sect. *Lanuginosa*. Each of the individual phenograms for the Long Ligule Group (Figure 3) and Short Ligule Group (Figure 4) show two large divisions as well; also discernible in Figure 1. Three of these clusters are very well aligned with the original groups delineated by Hitchcock and Chase. The cluster containing *D. acuminatum*, *D. thermale*, *D. subvillosum,* and *D. villosissimum* could constitute a fourth section united by short ligule, dense pubescence, a lack of puberulence, and spikelets around 2mm long.

Given the large morphological, ecological and geographical ranges of some of the species delimited in this treatment and the relatively few representative specimens of each within the dataset, there is reason to suspect that there may be other taxa, some potentially valid species, that were not detected in the analysis. For example, while *Dichanthelium thurowii* and *D. auburne* are here maintained in the synonymy of *D. acuminatum*, the specimens in the analysis, including the type material, coupled with the descriptions and the geographical ranges reported by Hitchcock and Chase (1910, 1950) suggest that the taxonomic clarity of *D. acuminatum* sensu stricto may be under-investigated. Also, the type specimen of *P. pseudopubescens* and the corresponding morphology could not be completely differentiated from the *D. villosissimum* clade on the phenogram and PCA cluster. A review of specimens raised enough questions that the morphological limits of this potential entity should be more thoroughly reviewed (see notes under *D. villosissimum*). The same can be said for what are treated here as *D. implicatum*, *D. lanuginosum*, *D. lindheimeri*, and *D. thermale* in that each appear to contain morphological expressions that correlated to different habitats and geographical ranges (see the taxonomic notes of each species for details). In each of these cases, more field work and data analysis are needed to determine whether these more cryptic morphologies are taxonomically meaningful.

Long Ligule Group

The results of the phenetic analysis (Figure 3), PCA (Fig. 5 and Table 5) and t-tests (Table 3) defend the segregation of ten entities that are here interpreted as nine species and one subspecies in the Long Ligule Group. With the exception of some subtlety between *Dichanthelium lanuginosum* and *D. implicatum*, all taxa in the Long Ligule Group demonstrated clear morphological distinction. While the phenetic analysis (Figure 3) showed considerable separation between *D. lanuginosum* and *D. implicatum*, there was some degree of overlap between the two in the scatter plots of the PCA (Figure 5). A second PCA involving only *D. lanuginosum* and *D. implicatum* (Fig. 7) further confirmed that, while these two taxa are morphologically similar, they are distinct and several other

studies (Allen 2001; Naczi 1998; Peterson et al. 2002; Rothrock & Reznicek 2001; Saarela et al. 2003; Binns et al. 2002) have used similar levels of distinction for separating closely related taxa as distinct species. Furthermore, *D. lanuginosum* significantly differs from *D. implicatum* ($P \leq 0.05$) by 10 of the 24 characters sampled (Table 5). Maximum leaf length, maximum leaf width, and the length of pubescence on the abaxial surface of the terminal vernal leaf are the strongest characters separating these two taxa. Given the distinctness of the majority of specimens and the narrower ecological niche of *D. implicatum* (restricted to acidic substrates in woodland habitats) these taxa are here treated as separate species.

The analysis did not well describe the full complement of morphological variation found within the *Dichanthelium thermale* complex. Specimens that have always been associated with the complex were found in both the Long Ligule and Short Ligule groups. Essentially, the data demonstrated that what is here called *D. thermale* subsp. *thermale* clearly possesses a short ligule backed by a longer pseudoligule and is only found along hot springs in northern California. What is here called *D. thermale* subsp. *sericeum* possesses a long ligule and only occurs near hot springs and geysers in the Rocky Mountains. However, a few specimens (such as the type for *P. ferventicola*) from Yellowstone National Park have intermediate ligule lengths and specimens from Banff, Alberta, (such as the type for *P. ferventicola* var. *papillosum*) have very short and wide leaves. As noted by Hitchcock and Chase (1910), pubescence characters and leaf dimensions for the *P. thermale* complex are variable across its range. Given this range of variability, the *D. thermale* complex was interpreted more from the raw data and a review of specimens than from the analysis (see notes under *D. thermale* for details). This resulted in the recognition of *D. thermale* subsp. *thermale* and subsp. *sericeum*, which is similar to the treatment of Freckmann and Lelong (2003). *Dichanthelium thermale* has been found to be dependent on a triple mutualism between a fungal endophyte and a viral symbiont, which provide it with remarkable thermal tolerance (Marquez et al. 2006). The uncertainty of the effect of this three-way mutualism on the morphology of these plants, coupled with the island-like distribution of their populations, necessitates a more detailed study than can be provided here.

While the PCA, phenetic analysis, and t-tests demonstrate strong differences between *Dichanthelium lanuginosum* and *D. lindheimeri*, the application of morphological characters to specimens can be challenging. Much of the separation generated in the analyses above originates from pubescence characters, where *D. lindheimeri* is mostly glabrous and *D. lanuginosum* is always pubescent. The two taxa are very similar especially when sparsely pubescent specimens of *D. lanuginosum* are encountered (see notes under *D. lindheimeri* for details on distinguishing these taxa). This similarity has led some authors to lump these taxa or treat one as a subspecific taxon of the other. Because of its glabrosity, *D. lindheimeri* is more closely linked with *D. spretum* in the PCA and phenetic analysis. While this may seem wholly artificial, plants from calcareous lake shores in the Great Lakes region (Voss 1972; Voss & Reznicek 2012) that are here treated as *D. lindheimeri* are morphologically similar to *D. spretum*. Said plants have the overall stature of *D. spretum* coupled with pubescence and floral characters more aligned with *D. lindheimeri* (for details see notes under *D. lindheimeri*). In the phenetic analysis the more sparsely pubescent specimens of *D. lanuginosum* sorted together in a branch of *D. lanuginosum*. These specimens represent what has been called *P. tennesseense* and *P. lindheimeri* var. *septentrionale*. Following a review of these OTUs, as well as numerous additional herbarium specimens, no clear distinction could be found to justify maintaining this cluster as an infraspecific taxon. The phenetic analysis likewise demonstrated other small, seemingly distinct, groups in the *D. lanuginosum* and *D. praecocius* branches. Upon investigation of these groups, no justification for subspecific separation could be found, based on morphology. This is not to say, however, that such distinctions do not exist.

Short Ligule Group

In the Short Ligule Group, the results of the phenetic analysis (Figure 4), PCA (Figure 6 and Table 6) and t-tests (Table 4) demonstrate the segregation of seven entities that are here interpreted as distinct species. One outlier within the *Dichanthelium columbianum* cluster in Figure 4 represents the type specimen of *P. scoparioides*. This specimen possesses all the traits of typical *D. columbianum* except for its larger spikelets. This is interpreted as the extreme maximum of the phenotypic plasticity found within *D. columbianum* rather than a distinct taxon. Gould and Clark (1978) placed *P. scoparioides* into synonymy under their broad interpretation of *D. acuminatum*. However, using their key and descriptions, the type specimen better fits their *D. sabulorum* var. *thinium* which is here treated as a synonym of *D. columbianum* (typical *D. sabulorum* and var. *patulum* are now under *D. portoricense* in section *Lancearia*). Freckmann and Lelong (2003) referred to *P. scoparioides* as being a sterile hybrid between *D. oligosanthes* and their broad interpretation of *D. acuminatum* (which includes *D. columbianum* of the present treatment). The possibility of *P. scoparioides* being a hybrid does not seem unreasonable. Given the numerous specimens reviewed throughout the range of *D. columbianum* it is abundantly clear that the spikelet length demonstrated by *P. scoparioides* is a rare exception to the otherwise narrow morphological range of *D. columbianum* for this character.

Similarly, one outlier within the *Dichanthelium acuminatum* cluster (Figure 4) represents the type specimen of *P. comophyllum*. It falls outside the main cluster due to its wider leaves and more densely pubescent adaxial leaf surfaces. Hitchcock and Chase (1910) and Gould and Clark (1978) treated it as a synonym of *P. acuminatum*, while Freckmann and Lelong (2002, 2003) did not include any mention of its placement within the section. Because this is a solitary specimen that does not currently appear to match any common morphological theme within the group, it is interpreted here as an aberrant specimen that is not characteristic of the more uniform morphology expressed by *D. acuminatum*.

According to the phenetic analysis and PCA, what is here treated as *D. subvillosum* is most similar to *Dichanthelium thermale* and *D. acuminatum*, though their geographic ranges and habitats differ strikingly. *Dichanthelium thermale* has a double vestiture of pubescence on the basal and lower leaf sheaths of the vernal culm, shorter pubescence on vernal sheaths, and only occurs in moist geothermal soils of the Cascade and Rocky Mountains. *Dichanthelium subvillosum* has a single vestiture throughout the vernal culm, a longer pubescence on the vernal sheaths, and does not occur in the habitat or near the altitudes of *D. thermale*. The geographical ranges of both *D. thermale* and *D. subvillosum* are restricted to northern North America while the range of *D. acuminatum* is limited to the coastal plain of the southeastern USA, Gulf of Mexico, and into South America (for details see notes under *D. thermale* and *D. subvillosum*).

The phenetic analysis of the Short Ligule Group shows some small groups within the larger branches of *Dichanthelium acuminatum* and *D. villosissimum*. It seems probable that there is some level of taxonomic resolution to be found in these subordinate groups, but they are below the threshold of distinction given the methodology of this study. Future investigations into the details of these species are certainly in order.

Relevance to Past Studies

The present study confirms that the treatment of Hitchcock and Chase (1910), with its recognition of 33 species and two varieties within what is now sect. *Lanuginosa*, over-emphasized the measurable morphological diversity found within the section. The plethora of names associated with the section is demonstrative of the inherent morphological variability within the group. Slow rates of communication between nineteenth-century botanists also contributed to an over-naming (160 names are currently associated with sect. *Lanuginosa*). Subsequent treatments, such as Gould and Clark (1978) and Freckmann and Lelong (2002, 2003), have attempted to narrow the taxonomic limits

within the section but have underestimated the morphological evidence that here justifies maintaining many of these taxa above the subspecific rank.

The most obvious difference between the current treatment and those of Gould and Clark (1978) and Freckmann and Lelong (2002, 2003) is the circumscription of *Dichanthelium acuminatum*. In the treatment of Gould and Clark (1978), 13 of the 15 species in the present treatment are placed into 8 varieties under *D. acuminatum*. They qualified their treatment with the statement "It may be that the taxa retained as varieties do not adequately delimit the recognizable populations of this extremely widely distributed and morphologically variable species." The treatment of Freckmann and Lelong (2003) placed 10 of the 15 species recognized in the present treatment into 10 subspecies of *D. acuminatum*. They stated that morphologically intermediate specimens derived from hybridization and autogamy produce "a reticulate pattern of intergradation between members of the section [*Lanuginosa*]." While introgression, hybridization, and autogamy could offer mechanisms for intermediate morphologies, such phenomena have not been systematically proven to exist in *Dichanthelium* and the present study failed to find a significant number of morphologically intermediate specimens. Of the nearly 3000 specimens reviewed during the present treatment, the vast majority were easily placed into the taxa as outlined below. In direct reference to their broad circumscription of *D. acuminatum* Freckmann and Lelong (2003) stated that "there appears to be widespread introgression from other *Dichanthelium* species, such as *D. dichotomum, D. sphaerocarpon, D. ovale*, and *D. aciculare*." The very few instances where specimens in this study were difficult to distinguish usually occurred where what appeared to be closely related species came into contact on the edges of their ranges. For example, along the southern tip of Lake Michigan where the northeastern terminus of the Tallgrass Prairie Ecoregion meets the sandy soils of the black oak savannas of northern Illinois and Indiana, *D. praecocius* and *D. villosissimum* can be difficult to differentiate and are suggestive of some level of introgression. However, such putatively intergrading specimens are rare and do not warrant expunging the taxonomic, ecological, and biogeographical relevance that maintaining these entities as distinct species otherwise provides throughout the vast majority of their ranges. This level of what is often interpreted as hybridization or introgression is both acceptable and even expected in other complex groups (*Symphyotrichum*, *Solidago*, *Carex*, *Quercus*, etc.) without the dissolution of species with an otherwise high morphological fidelity and geographical predictability throughout the majority of their respective ranges. When such rare hybrid events, the mechanisms and consequences for which we do not fully understand, are used to justify the subsumption of taxa, we deny ourselves access to the real-world expressions of evolutionary development, function, and existence, as well as the chance to celebrate them. These hybrid moments should be described and named and not misconstrued as mortar in an imaginary wall of taxonomic reticulation.

Gould and Clark (1978) initiated, and Freckmann and Lelong (2002, 2003) maintained, a broad interpretation of *D. ovale*, though the two treatments differ significantly. Gould and Clark (1978) placed what is here treated as *Dichanthelium commonsianum* as a variety of *D. ovale* (var. *addisonii*, which is placed in synonymy with *D. columbianum* in the present treatment) and maintained the typical variety to represent what had traditionally been *D. ovale*. The basis of that treatment, as gleaned from their keys, seems to be the presence of a double vestiture on the vernal sheaths, longer spikelets, and the distribution of pubescence along the adaxial surface of vernal leaves. While the present study failed to confirm any differences in adaxial leaf pubescence or spikelet length, the presence and extent of a double vestiture along the vernal sheaths did prove informative. Freckmann and Lelong (2002, 2003) proposed an even broader interpretation of *D. ovale* that includes *D. villosissimum* and *D. praecocius* (as subsp. *villosissimum* and subsp *praecocius*) and incorporated *D. commonsianum* into subsp. *pseudopubescens* (see notes under *D. ovale* for details). In their treatment of *D. ovale*, Freckmann and Lelong (2002, 2003) and Lelong

(1984) are the only authors to combine taxa from the informal groups *Columbiana* and *Lanuginosa* of Hitchcock and Chase (1910).

Like the present treatment, Freckmann and Lelong (2003) maintained *Dichanthelium wrightianum* as a distinct species. However, Gould and Clark (1978) chose to place *D. wrightianum* as a variety of *D. acuminatum*. Given its diminutive stature and consistently tiny spikelets (0.8 to 1.0 mm long), there should be little debate regarding the distinct nature of this taxon. It is difficult to envision it being treated as anything other than a substantiated species.

Though it is not always a primary concern of taxonomy, the conservation status, political protection, and ultimately the degree of intellectual investment from field biologists that rarely interest themselves in a regional flora below the level of species are greatly affected by the ultimate utility of taxonomy. Recognizing ten subspecies under *Dichanthelium acuminatum* is not only taxonomically unsatisfying but it also diminishes the potential for protecting such conservative and regionally imperiled species as *D. columbianum*, *D. longiligulatum*, *D. praecocius*, *D. meridionale*, *D. spretum*, and *D. thermale*. It is a matter of opinion, but if there is any question as to the distinctness of these entities as isolated evolutionary lineages, taxonomists are obligated to err on the side of caution and maintain such taxa as species until we better understand their significance rather than learn too late that we too eagerly dismissed their uniqueness.

Sources of confusion

Much of the past confusion within sect. *Lanuginosa* originates from the varying interpretations of taxonomically useful characters. Most treatments have relied heavily on spikelet length, the length of the ligule, and characters involving the indument. The present study has also found that these traits provide clarity but only for certain species and in conjunction with other characters. Furthermore, when applied to the section, characters like spikelet length, double ligule, and double vestiture require a more detailed characterization than most treatments provide. Spikelet length in the present treatment is defined as the length of the spikelet from the base of the first glume to the tip of the second glume. Where possible the most mature spikelets of the vernal inflorescence should be used. Immature spikelets and those of the autumnal inflorescence are often highly variable and can result in inconsistent measurements.

Characterization of the diverse expressions in the ligule length, shape, and uniformity can also be problematic. Members of the Long Ligule Group, such as *Dichanthelium lanuginosum* and *D. implicatum*, possess a "single ligule," which means there is no pseudoligule or that the hairs of the ligule and the pseudoligule are of the same length and thereby not discriminable (Fig 8a). This is in contrast to members of the Short Ligule Group like *D. ovale* and *D. columbianum*, which often have a "double ligule" or a distinct pseudoligule, where the true ligule is composed of short hairs and the pseudoligule is composed of longer hairs behind the ligule. The hairs of the pseudoligule originate from the immediate adaxial leaf surface (Figure 8b). Adding to the confusion, some taxa that typically have a longer pseudoligule occasionally lack it (corresponding to glabrous adaxial leaf surfaces) and thus appear to possess a "single" short ligule (Figure 8c). In herbarium specimens, distinguishing the ligule and pseudoligule can often be problematic because the ligule and pseudoligule (when both are present) may become intermeshed during the drying process (Figure 8d). One would think this a simple matter, but several of the type specimens reviewed for this project possessed a ligule type that differs significantly from that in the author's original description (included ligule and pseudoligule in original measurements for "ligule," for example). In the present treatment the key to taxa breaks from this traditional terminology by referring only to the first row of ligule hairs. This avoids the confusion associated with ligule and pseudoligule and focuses attention on the relevant issue of whether the immediate hairs (first row) are long or short.

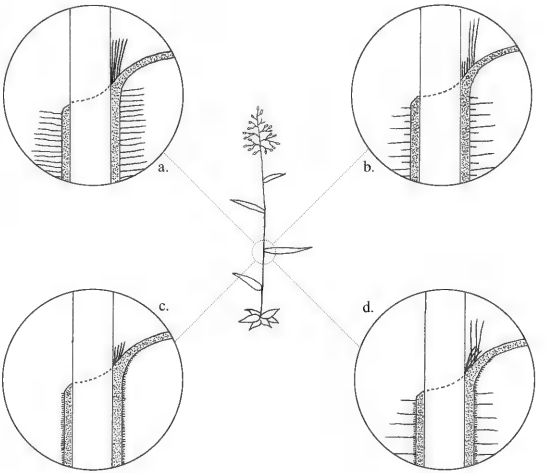


Figure 8. Examples of the four ligule types and the four pubescence types found within section *Lanuginosa*. All combinations of the eight illustrated characters are possible. **Ligule illustration a.)** occurs in *D. implicatum*, *D. lanuginosum*, *D. leucothrix*, *D. lindheimeri*, *D. longiligulatum*, *D. meridionale*, *D. praecocius*, *D. spretum*, *D. thermale* subsp. *sericeum* and *D. wrightianum*; **b.)** occurs in *D. acuminatum*, *D. columbianum*, *D. commonsianum*, *D. ovale*, *D. subvillosum*, *D. thermale* and *D. villosissimum*; **c.)** occurs in *D. columbianum*, *D. commonsianum* and *D. ovale*; **d.)** occurs in *D. acuminatum*, *D. columbianum*, *D. meridionale*, *D. subvillosum*, *D. thermale* subsp. *sericeum* and *D. thermale* subsp. *thermale*. **Pubescence illustration a.)** occurs in *D. acuminatum*, *D. implicatum*, *D. lanuginosum*, *D. praecocius*, *D. thermale* subsp. *sericeum* and *D. villosissimum*; **b.)** occurs in *D. acuminatum*, *D. subvillosum*, *D. thermale* subsp. *thermale* and *D. villosissimum*; **c.)** occurs in *D. columbianum*, *D. commonsianum*, *D. leucothrix* and *D. wrightianum*; **d.)** occurs in *D. columbianum*, *D. commonsianum*, *D. leucothrix*, *D. meridionale*, *D. ovale*, *D. thermale* subsp. *thermale* and *D. wrightianum*.

Another character state that has caused confusion in the group is the presence or absence of a "double vestiture" in reference to sheaths, internodes, peduncles, and the axes of the inflorescences. This is problematic because two types of double vestiture are possible for taxa in sect. *Lanuginosa*. First, taxa that typically have a single vestiture of long pilose hairs (Fig. 8a) can occasionally have an additional indument of short pilose hairs (Fig. 8b). Second, some taxa have long pilose hairs above short puberulent hairs (Fig. 8d). In the latter case, some specimens can lack the longer pilosity (Fig. 8c) and thus do not truly have a "double vestiture." All previous treatments that have utilized the "double vestiture" character to distinguish taxa have failed to define these subtleties. To avoid this confusion in the present treatment, any reference to "double vestiture" includes a description of whether the subordinate pubescence is pilose or puberulent. Because the distinguishing features of

the ligule, spikelet, and sheath pubescence can be minute, a minimum of 30X magnification is required to fully discern the differences in taxa. Furthermore, all measurements regarding these characters should be taken with calipers or a sub-millimeter scale while under a dissecting scope.

Because the morphology of the autumnal branches and inflorescences often differ strikingly from that of the vernal culms and inflorescences, all key characters in the present treatment are in reference to the vernal culm. The autumnal branches, leaves, and inflorescences of most taxa in the section become highly fascicled and finely pubescent late in the summer. This is often accompanied by the senescence of the vernal stem leaves. Thus, plants collected late in the season become increasingly difficult to identify. The exceptions to this are *Dichanthelium implicatum* and *D. columbianum*, both of which have the distinct feature of the vernal leaves curling under into a nearly circular configuration. No other members of the section do this. As the collector of *Carex* must be mindful of the shattering of perigynia from the spike, the collector of *Dichanthelium* should seek specimens that possess fresh components of the vernal stem and thus the full complement of morphological expression.

The most problematic source of confusion in sect. *Lanuginosa* is the relationship of *Dichanthelium lanuginosum* and *D. acuminatum*. Much of this confusion seems to stem from the regional misapplication of names. *Dichanthelium acuminatum*, long considered a species of the Caribbean, was not considered to be an element of the flora of North America until the treatment of Gould and Clark (1978). It appears to have been mistakenly called *Panicum lanuginosum* prior to this clarification (Hitchcock & Chase 1910; Small 1903, 1933). The name *P. lanuginosum* was also being applied, correctly so, to plants of the interior of North America. In 1910, Hitchcock and Chase designated the name *P. lanuginosum* to plants of the southern coastal plain and relegated the plants of the interior to *P. huachucae*. Finding little to no difference between specimens of *P. huachucae* and earlier published names such as *P. lindheimeri* and *P. implicatum* (*Dichanthelium lindheimeri* and *D. implicatum* of the present treatment), the regional treatments of Fernald (1922), Pohl (1947), Shinners (1944), Voss (1972), and Swink and Wilhelm (1994) utilized these earlier names for plants in their respective regions. Fernald (1934, 1950), attempted to correct this discrepancy and realigned these taxa with *P. lanuginosum* by placing *P. lindheimeri*, *P. implicatum*, as well as other species, as varieties of *P. lanuginosum* while restricting the typical variety to the southern coastal plain (apparently still in reference to what we now call *D. acuminatum*). In Fernald's realignment, *P. lanuginosum* var. *fasciculatum* (of which *P. huachucae* is a synonym) came to represent the most wide-ranging taxon of the section in the interior of North America. In 1978, Gould and Clark became the first authors to include *D. acuminatum* into the flora of North America. However, instead of maintaining *D. lanuginosum* as distinct from *D. acuminatum* they placed it and all the above-mentioned taxa, plus several others, into synonymy with *D. acuminatum*. A similar arrangement was maintained by Freckmann and Lelong (2002, 2003).

While inclusion of *Dichanthelium acuminatum* in the North American flora helped clarify this issue, the placement of *D. lanuginosum* in synonymy with *D. acuminatum* is not justified by the findings of this study. In fact, for reasons mentioned throughout, morphological, ecological, geographical, and taxonomic clarity is maximized by extracting *D. lanuginosum* from *D. acuminatum*. The type of *D. lanuginosum* is more velvety pubescent than most of the more western specimens of the taxon — so much so that one wonders if it may actually represent a more eastern cryptic expression. In this case the western expression becomes better aligned with *P. huachucae* of Hitchcock and Chase (1910, 1951), *P. lindheimeri* of Fernald (1922), *P. implicatum* of Pohl (1947) and Voss (1972), and *P. lanuginosum* var. *fasciculatum* of Fernald (1934, 1950) and Gleason and Cronquist (1991). Should future studies find a stronger difference between the coastal and interior manifestation of *P. lanuginosum*, those of the interior would be relegated back to either Fernald's var. *fasciculatum* or the species "*huachucae.*"

Confusion also has risen from taxa outside sect. *Lanuginosa*. Specimens of *Dichanthelium consanguineum* (sect. *Angustifolia*) and *D. laxiflorum* (sect. *Strigosa*) are commonly encountered in the herbarium folders of taxa from sect. *Lanuginosa* as misidentifications. *Dichanthelium consanguineum* differs from all members of sect. *Lanuginosa* in having attenuate spikelets and thin primary glumes. Because it often has a light puberulence on the culm, it is often confused with *D. ovale* or *D. commonsianum*. *Dichanthelium laxiflorum* differs in having longer winter rosette leaves and culm leaves that are more basally disposed. It often has more of a yellow-green coloration, a smaller ligule, and more extensive cilia on the leaf margins than members of sect. *Lanuginosa*. It most resembles *D. acuminatum* and *D. villosissimum*.

TAXONOMIC TREATMENT

Dichanthelium sect. ***Lanuginosa*** (Hitchc.) Freckmann & Lelong. **Plants** caespitose, 5–120 cm, glabrous to densely pilose, villose or puberulent. **Basal rosettes** conspicuous and over-wintering. **Culms** erect early in the season, often sprawling later. **Leaves** evenly distributed along the culm, almost always less than 1 cm wide. **Ligules** a dense ring of hairs, 0.2–5.0 mm long, often backed by a pseudoligule. **Spikelets** 0.8–3.0 mm long, elliptic to ovate-elliptic, pubescent, the first glume ¼ to ½ the spikelet length, the second glume and sterile lemma 5–9 nerved.

1. First row of ligule hairs ≥ 1.7 mm long (key intermediate specimens here).

   2. Surfaces of distal and midstem leaf sheaths of vernal culms glabrous or glabrate (ignore hairs restricted to the sheath margins).

      3. Inflorescence < 1/3 as wide as long; spikelets acute to attenuate at the apex and ovate to lanceolate in outline; leaves and sheaths rigid with a stiff, smooth texture; inflorescences densely flowered; collar region of vernal leaves ciliate ..... **Dichanthelium spretum**
      3. Inflorescences at least ½ as wide as long; spikelets obtuse at the apex and elliptic to elliptic-ovate in outline; leaves and sheath thin with a papery texture; inflorescences sparsely flowered; collar region of vernal leaves most often ciliate.

         4. Spikelets 1.3 – 1.7 mm long; base of proximal vernal stem leaves with marginal cilia; largest leaves of the vernal culm typically > 60 mm long and 5 mm wide (similar to the proportions of *D. lanuginosum*); stems thickish and with typical autumnal fascicles ..... **Dichanthelium lindheimeri**
         4. Spikelets usually 1.1 – 1.5 mm long; base of proximal vernal stem leaves usually lacking marginal cilia or restricted to less than three hairs per side; largest leaves of the vernal culm typically < 60 mm long and 5 mm wide; stems wiry with autumnal fascicles dense and pom-pom like ..... **Dichanthelium longiligulatum**

   2. Surfaces of distal and usually midstem leaf sheaths of vernal culms pubescent with a uniform indument of variable density (note: some taxa possess a very short puberulence of hairs between the veins of the sheath that require 10X magnification).

      5. More than 30 cilia on each margin of the middle and lower leaves of the vernal culm; marginal cilia extending from the base of the leaves to approximately half way up the blade ..... **Dichanthelium acuminatum** (in part)
      5. Less than 20 cilia on each margin of the middle and lower leaves of the vernal culm; marginal cilia restricted to the basal ¼ of the blade.

         6. Plants restricted to hot geothermal soils of the Cascade and Rocky Mountains.

7. Largest vernal stem leaves < 8 mm wide; pubescence on the vernal sheaths < 2.0 mm long ..... **Dichanthelium thermale** subsp. **thermale** (in part)
7. Largest vernal stem leaves > 8 mm wide; pubescence on the vernal sheaths > 2.0 mm long ..... **Dichanthelium thermale** subsp. **sericeum**

6. Plants never growing in hot geothermal soils.

8. Upper surface of mid-stem leaves of vernal culms lacking pubescence along the central one third of the blade from base to tip .. **Dichanthelium columbianum** (in part)
8. Upper surface of mid-stem leaves of vernal culms uniformly pubescent across the surface (margin to margin) or glabrous.

9. Plants with a puberulent pubescence (less than 0.3 mm long) on the under surfaces of vernal stem leaves; main axis of the inflorescence possessing a puberulent pubescence often beneath longer pilose hairs; largest vernal leaves 22–65 mm long; spikelets often puberulent.

10. Spikelets ≤ 1.1 mm long and 0.5 mm wide ..... **Dichanthelium wrightianum**
10. Spikelets ≥ 1.2 mm long and 0.5 mm wide.

11. Longer hairs of the mid-stem sheaths and the upper leaf surfaces of vernal stem leaves ≤ 2 mm long; other than occasional puberulence, upper surface vernal stem leaves with sparse pilosity or lacking pilosity; almost exclusively a species of coastal regions from New Jersey south through the Gulf of Mexico to northern South America and the Antilles ..... **Dichanthelium leucothrix**
11. Longer hairs of the mid-stem sheaths and the upper leaf surfaces of vernal stem leaves mostly > 2 mm long the upper surface of vernal leaves conspicuously pilose; a species of southern Canada and the northern USA south to Georgia and Alabama including coastal and inland regions ..... **Dichanthelium meridionale**

9. Plants lacking hairs or with a velutinous, pilose or hispid pubescence on the under surfaces of vernal stem leaves; main axis of the inflorescence lacking a puberulent pubescence; largest vernal leaves 40–110 mm long; spikelets not puberulent.

12. Spikelets 1.8–2.1 mm long; first glume 0.7–1.0 mm long; longest hairs of the mid-stem vernal sheaths mostly 2.7–4.5mm long; often 10 or fewer nodes along the central axis of the inflorescence; ligule a mixture of long and short hairs with shorter hairs more abundant in the center thereby creating a U-shaped ligule in general outline; leaves often ascending; endemic to the Tallgrass Prairie Ecoregion ..... **Dichanthelium praecocius**
12. Spikelets 1.3–1.8 mm long; first glume 0.3–0.7 mm long; longest hairs of the mid-stem vernal sheaths usually < 2.7 mm long; usually 12 or more nodes along the central axis of the inflorescence; ligule hairs approximately the same length throughout; leaves spreading; widespread.

13. Largest vernal leaves typically ≤ 65 mm long; vernal stem leaves typically < 6.0 mm wide; plants growing in acidic substrates and usually at sites with significantly high native floristic quality; typical habitats include sandy or cherty woodlands, prairies and glades as well as bogs, cedar swamps, tamarack swamps ..... **Dichanthelium implicatum**

13. Largest vernal leaves typically > 65 mm long; vernal stem leaves typically > 6.0 mm wide; plants more often associated with neutral or alkaline soils and not indicative of high native floristic quality; typical habitats include old fields, woodlands, prairies and glades ..... **Dichanthelium lanuginosum**

1. First row of ligule hairs ≤ 1.5 mm long.

14. Upper surfaces of vernal stem leaves glabrous or glabrate along entire blade

15. Lower and basal sheaths possessing a single indument of long villose pubescence and lacking an additional short puberulence (occasional specimens may have pilose hairs under the villose hairs) ..... **Dichanthelium villosissimum** (in part)

15. Lower and basal sheaths possessing a double vestiture of long pilose or villose pubescence above a short puberulence or only possessing a short puberulence.

16. Spikelets ≤ 2.1 (rarely to 2.4) mm long; ligule usually > 1 mm long; first glume ≤ 1 mm long ..... **Dichanthelium columbianum** (in part)

16. Spikelets > 2.1 mm long; ligule usually ≤ 1 mm long; first glume typically > 1 mm long

17. Distal sheath of vernal culms possessing a short puberulence (often below longer or villose hairs); ligule of vernal stem leaves > 0.7 mm long ..... **Dichanthelium commonsianum** (in part)

17. Distal sheath of vernal culms glabrous, pilose or villose but lacking a short puberulence; ligule of vernal stem leaves < 0.7 mm long ..... **Dichanthelium ovale** (in part)

14. Upper surfaces of vernal stem leaves conspicuously pubescent.

18. Upper surface of mid-stem leaves of vernal culms uniformly pubescent across the surface (margin to margin).

19. More than 30 cilia on each margin of the middle and lower leaves of the vernal culm; marginal cilia extending from the base of the leaves to approximately half way up the blade ..... **Dichanthelium acuminatum** (in part)

19. Less than 20 cilia on each margin of the middle and lower leaves of the vernal culm; marginal cilia restricted to the basal ¼ of the blade.

20. Lower and basal sheaths possessing a double vestiture of long pilose or villose hairs above shorter pilose or puberulent hairs

21. Plants restricted to hot geothermal soils of the Cascade, Sierra Nevada and Rocky Mnt ranges ..... **Dichanthelium thermale** subsp. **thermale** (in part)

21. Plants not growing in hot geothermal soils ..... **Dichanthelium columbianum** (in part)

20. Lower and basal sheaths possessing a single indument solely of villose hairs

22. Indument of vernal stem sheaths > 2 mm long; spikelets > 1.9 mm long ..... **Dichanthelium villosissimum** (in part)

22. Indument of vernal stem sheaths < 2 mm long; spikelets < 1.9 mm long ..... **Dichanthelium subvillosum**

18. Upper surface of mid-stem leaves of vernal culms lacking pubescence along the central portions of the blade (lacking pubescence along the central one third of the blade from base to tip).

23. Spikelets ≤ 2.1 (rarely to 2.4) mm long; ligule usually > 1.0 mm long; first glume ≤ 1.0 mm long ..... **Dichanthelium columbianum** (in part)
23. Spikelets > 2.1 mm long; ligule usually ≤ 1.0 mm long; first glume typically > 1.0 mm long.

24. Distal sheath of vernal culms possessing a short puberulence (often below longer pilose or villose hairs); ligule of distal vernal stem leaves > 0.7 mm long ..... **Dichanthelium commonsianum** (in part)
24. Distal sheath of vernal culms glabrous, pilose or villose but lacking a short puberulence; ligule of distal vernal stem leaves < 0.7 mm long ..... **Dichanthelium ovale** (in part)

1. DICHANTHELIUM ACUMINATUM (Sw.) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1121. 1978. *Panicum acuminatum* Sw., Prodr. 23. 1788. *Panicum dichotomum* var. *acuminatum* (Sw.) Griseb., Fl. Brit. W.I. 553. 1864. **TYPE: JAMAICA**: locality unknown, *Swartz s.n.* (holotype: S; isotypes: BM, US!).

Panicum ciliosum Nash, Bull. Torrey Bot. Club 26: 568. 1899. **TYPE: USA. Mississippi**. Harrison Co.: Biloxi, 1 Sep 1898, *Tracy 4580* (holotype: NY!; isotypes: NCU, US!).

Panicum orangense Ashe, J. Elisha Mitchell Sci. Soc. 15: 113. 1899. **TYPE: USA. North Carolina**. Orange Co.: Chapel Hill, 29 Jun 1898, *Ashe s.n.* (lectotype: US!, designated by Hitchcock & Chase, Contr. U.S. Natl. Herb. 15: 220. 1910).

Panicum thurowii Scribn. & J.G. Sm., Circ. Div. Agrostol. USDA 16: 5. 1899. *Dichanthelium acuminatum* var. *thurowii* Gould & Clark, Ann. Missouri Bot. Gard. 65: 1125. 1978. *Panicum acuminatum* var. *thurowii* (Scribn. & J.G. Sm.) Reed, Phytologia 67: 452. 1989. **TYPE: USA. Texas**. Waller Co.: locality unknown, 5 Jun 1898, *Thurow 9* (holotype: US!; isotype: US!).

Panicum auburne Ashe, North Carolina Agric. Res. Serv. Bull. 175: 115. 1900. *Dichanthelium auburne* (Ashe) Mohlenbr., Vasc. Fl. Illinois 419. 2002. **TYPE: USA. Alabama**. Lee Co.: Auburn, 7 May 1898, *Earle & Baker 1527* (holotype: NCU!; isotypes: NY!, US!).

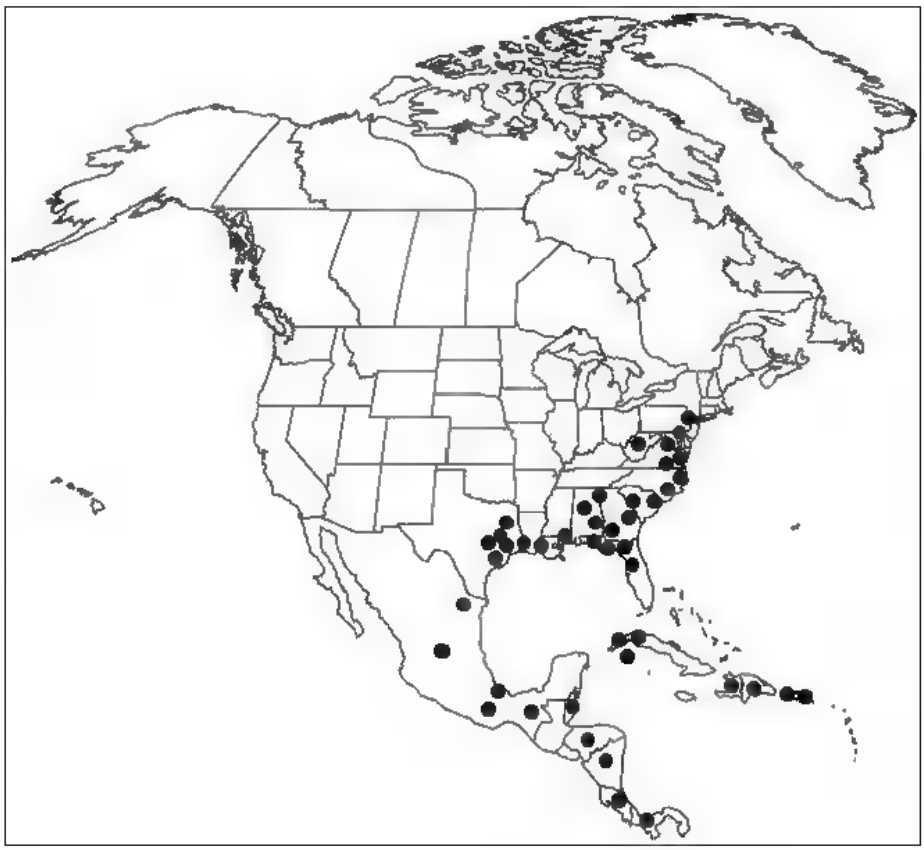
Panicum comophyllum Nash, Bull. Torrey Bot. Club 30: 380. 1903. **TYPE: PUERTO RICO**. San Juan: collected in rich soil at Santurce, 9 Jan 1899, *Heller 12* (holotype: NY!; isotype: fragment US).

Panicum olivaceum Hitchc. & Chase, Contr. U.S. Natl. Herb. 15: 225. 1910. **TYPE: GUATEMALA**. Alta Verapaz: Coban, 1400 m, Feb 1888, *Tuerckheim 428* (holotype: US!; isotypes: ISC!, US!)

Panicum glutinoscabrum Fernald, Rhodora 49:122. 1947. **TYPE: USA. Virginia**. Nansemond Co.: sphagnous and peaty bog by Norfolk and Western Railway, *Fernald, Long, & Clement 15186* (holotype: GH!; isotypes: PH, US!).

Plants erect or ascending from a geniculate base, 20–70 cm tall; lower **internodes** double invested with short, often sparse, pilose hairs below longer villose hairs (Figure 8b, for pubescence type), mid-stem and upper-stem internodes single invested with velutinous or villose hairs (Figure 8a, for pubescence type); **sheaths** conspicuously velutinous to villose (Figure 8a) with hairs 0.2–2.5 mm long, the lower stem sheaths double invested with short, pilose hairs and longer villose hairs (Figure 8b) 0.4–1.3 mm long; **pseudoligule** distinct, 2–4 mm long; **leaf blades** spreading to ascending, 3–12 cm long, 4–13 mm wide, margins ciliate on at least the lower half, adaxial leaf surface glabrate to villous, abaxial surface velutinous; **panicles** 3–11 cm long, half as wide to as wide as long, pilose to

velutinous; **spikelets** 1.6–2.1 mm long, approximately 1 mm wide, elliptic, pilose; **first glume** 0.4–0.9 mm long, typically equal or less than 1/3 the length of the spikelet, acute to broadly acute.



Distribution and habitat. *Dichanthelium acuminatum* is found along the eastern and southern coastal plain of North America, eastern Central America, northern South America, and throughout the Antilles. In North America, it occurs with increasing rarity from coastal regions into the interior. The full extent of its distribution outside of North America is not well documented. Its habitat consists primarily of open woodland and grassland communities with sandy soil.

Representative specimens. BELIZE. Orange Walk District. 25 Jul 1980, *Dwyer & Berry 15016* (MO). **COLOMBIA. Cauca**. 1889, *Lehmann 974* (GH). **COSTA RICA. San Jose**. 26 Dec 1925, *Standley & Valerio 43377* (GH). **DOMINICAN REPUBLIC. Santo Domingo**. 13 Feb 1929, *Ekman 11547* (GH). **GUATEMALA**. Alta Verapaz, Feb 1888, *Turckheim 428* (MO,US). **HAITI**. 28 Sep 1943, *Holdridge 1727* (MO). **HONDURAS. Francisco Morazan**. 23 Oct 1951, *Swallen 11012* (MO). **JAMAICA**. 24 Jan 1913, *Harris 11597* (GH). **MEXICO. Chiapas**. 15 Nov 1984, *Davidse 29845* (MO). **Oaxaca**. 14 Aug 1975, *Davidse & Davidse 9688* (MO). **Tabasco**. 8 Aug 1975, *Davidse 9368* (MO). **Vera Cruz**. 2 Sep 1910, *Hitchcock 134* (MO). Oct 1927, *Purpus 7879* (MO). **NICARAGUA**. Nueva Segovia, 10–13 Aug 1977, *Stevens & Krukoff 3271* (MO). **PANAMA. Chiriqui**. 25 Jun 1938, *Davidson 766* (GH). **USA. Alabama**. Lee Co.: 7 May 1898, *Earle & Baker 1527* (NY). **Florida**. Franklin Co.: *Chapman 7189* (MO). **Georgia**. Burke Co.: 4 Jun 1964, *Freckmann 1180* (MO). **Louisiana**. Acadia Par.: 17 Apr 1913, *Chambliss s.n.* (MO). Jeff Davis Parish, 15 May 1915, *Palmer 7610* (MO). **Mississippi**. Harrison Co.: 1 Sep 1898, *Tracy 4580* (US). **North Carolina**. Orange Co.: 29 Jun 1898, *Ashe s.n.* (US). **Puerto Rico**. 17 Jan 1886, *Hackel 5908* (GH). 9 Jan 1899, *Heller 12* (NY). **Texas**. Montgomery Co.: 11 May 1980, *Morden 29* (MO). Polk

Co.: 10 May 1973, *Gould, Hatch, & Waller 14233A* (MO). Upshur Co.: 28 May 1901, *Reverchon 2355* (MO). Waller Co.: 5 Jun 1898, *Thurow 9* (US). **Virginia**. Nansemond Co.: 2 & 12 Sep 1946, *Fernald, Long, & Clement 15186* (GH).

The treatment of *Dichanthelium acuminatum* presented here is much more restrictive than that of Gould and Clark (1978) and Freckmann and Lelong (2002, 2003) but less so than the treatment of Hitchcock and Chase (1910 and 1950); see discussion for more details. The data demonstrate that *D. acuminatum*, in the present sense, is morphologically distinct from other members of the section in that the stems and leaves are densely pubescence, it has a double ligule consisting of a short true ligule backed by a conspicuous pseudoligule, and, unlike all other members of the section, it has conspicuous marginal cilia that typically extend at least half way up the margins of vernal leaf blades. These marginal hairs have pustulate bases that can be detected even in older specimens that have lost the hairs; abaxial hairs are easily misinterpreted as originating from the margin, so caution and microscopy are recommended. Typically, *D. acuminatum* is the most densely and softly pubescent member of the section and the abaxial blade surfaces of vernal stem leaves are soft to the touch. It also produces an abundance of rosette leaves, which are often proportionately larger than the leaves of other species in the section. This character along with the previously mentioned ciliate leaf margins is reminiscent of members of sect. *Laxiflorae*.

Hitchcock and Chase (1910) maintained the separation of *Panicum olivaceum* and *P. thurowii* from *P. acuminatum* based on plant color. While variation does exist, the abundance of intermediates and the many factors that can influence plant color suggest that this character lacks taxonomic value and consistency. In fact, there appears to be a tendency toward thicker leaves and a more olive-green coloration in many species of grass collected from coastal areas and subtropical regions compared to the same species from interior and temperate regions (personal observ.). Gould and Clark (1978) maintained var. *thurowii* in reference to more robust specimens than typical. While a review of specimens in the present study did suggest some interesting range in morphological variation, the data did not support it as distinct. Similarly, specimens approximating what Hitchcock and Chase (1910) maintained as *P. auburne* demonstrated some intriguing differences in morphology such as a smaller stature, smaller spikelets, and narrower leaves. Also, specimens that could be interpreted as *P. auburne* occurred on the northern fringe of what would otherwise be a narrow circumscription of what is here interpreted as *Dichanthelium acuminatum*. Ultimately, the data analysis strongly supports *D. acuminatum* as a distinct morphological cluster. Subunits of morphological variation within this cluster, though not found to be significant in this study, do maintain the suggestion of cryptic taxa within *D. acuminatum*. Future investigations attempting to more intimately understand these relationships will undoubtedly require extensive field familiarity.

2. DICHANTHELIUM COLUMBIANUM (Scribn.) Freckmann, Phytologia 39: 270. 1978. *Panicum columbianum* Scribn., Bull. Div. Agrostol. USDA 7: 78. 1897. *Panicum acuminatum* var. *columbianum* (Scribn.) Lelong, Brittonia 36: 270: 1984. *Dichanthelium acuminatum* subsp. *columbianum* (Scribn.) Freckmann & Lelong, Sida 20: 167. 2002. **TYPE: USA. District of Columbia**. Brookland, 14 Jul 1894, *Scribner s.n.* (holotype: US!; isotypes: NCU, NY!).

Panicum addisonii Nash, Bull. Torrey Bot. Club 25: 83–84. 1898. *Panicum commonsianum* subsp. *addisonii* (Nash) W. Stone, New Jersey State Mus. Annual Rep. 1910: 205. 1911. *Panicum commonsianum* var. *addisonii* (Nash) Fernald, Rhodora 37: 391. 1935. *Dichanthelium ovale* var. *addisonii* (Nash) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1115. 1978. *Panicum ovale* var. *addisonii* (Nash) C.F. Reed, Phytologia 67: 452. 1989. **TYPE: USA. New Jersey**. Cape May Co.: in sandy soil at Wildwood, 30 & 31 May 1897, *Bicknell s.n.* (holotype: NY!; isotypes: NY!, US).

Panicum scoparioides Ashe, J. Elisha Mitchell Sci. Soc. 15: 53. 1898. *Panicum villosissimum* var. *scoparioides* (Ashe) Fernald, Rhodora 36: 79. 1934. *Dichanthelium scoparioides* (Ashe)

Mohlenbr., Erigenia 6: 26. 1985. **TYPE: USA**. **Delaware**. New Castle Co.: Centerville, dry soil, 25 Jun 1873, *Commons s.n.* (lectotype: US!, designated by Gould & Clark, Ann. Missouri Bot. Gard. 65: 1123. 1978; isotype: NY!).

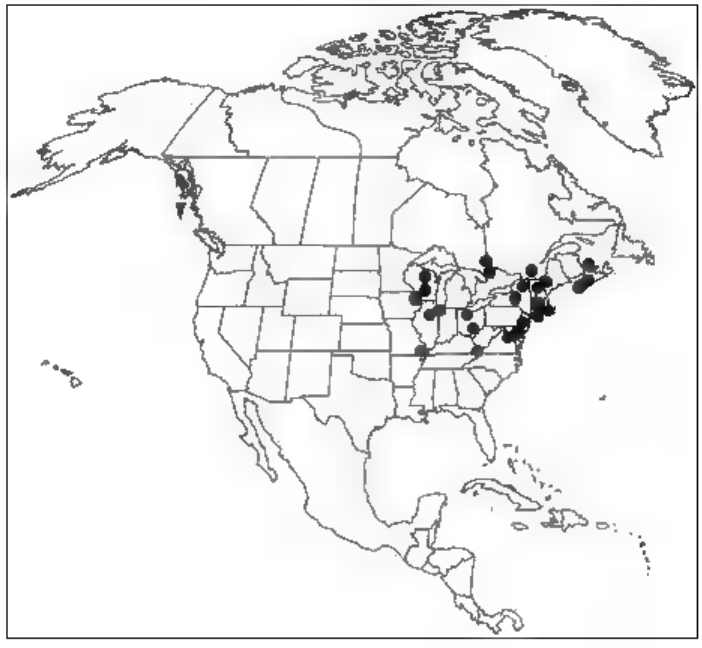
Panicum tsugetorum Nash, Bull. Torrey Bot. Club 25: 86. 1898. **TYPE: USA**. **New York**. Bronx Co.: locality unknown, *Nash 287* (holotype: NY!; isotype: US!).

Panicum laruginosum var. *siccanum* Hitchc. & Chase, Rhodora 8: 207–208. 1906. *Panicum columbianum* var. *siccanum* (Hitchc. & Chase) Boivin, Le Naturaliste Canadien 95: 526. 1967. **TYPE: USA**. **Illinois**. La Salle Co.: Starved Rock, dry hot sand of sandstone cliff, 13 Jul 1901, *Chase 1602* (holotype: US!).

Panicum unciphyllum var. *thinium* Hitchc. & Chase, Rhodora 8: 209. 1906. *Panicum columbianum* var. *thinium* (Hitchc. & Chase) Hitchc. & Chase, Rhodora 10: 64. 1908. *Panicum heterophyllum* var. *thinium* (Hitchc. & Chase) Hubb, Rhodora 14: 172. 1912. *Dichanthelium sabulorum* var. *thinium* (Hitchc. & Chase) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1113. 1978. **TYPE: USA**. **New Jersey**. Toms River, in mats, sandy open ground, 28 Jul 1906, *Chase 3577* (holotype: US!).

Panicum owenae E.P. Bicknell, Bull. Torrey Bot. Club 35: 185. 1908. **TYPE: USA**. **Massachusetts**. Nantucket Co.: Nantucket, on the sandy commons west of town, 20 Sep 1907, *Bicknell s.n.* (holotype: NY!; isotype: US).

Plants erect or ascending from a geniculate base, 10–50 cm tall; **internodes** and **sheaths** pubescence of short puberulent to pilose hairs and long villose hairs (Figure 8d), occasionally lacking the longer villose hairs on the middle and upper internodes and sheaths (Figure 8c),longer hairs 0.3–2.0 mm long when present; **ligule** 0.9–1.5 mm long; **pseudoligule** sparse, intermeshed, or commonly absent (see Figs. 7b, c or d); **leaf blades** spreading to ascending, 3–9 cm long, 3–8 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface villose to glabrate, hairs absent along the central third of the blade, abaxial surface with appressed puberulence; **panicles** 2–8 cm long, half as wide to as wide as long, puberulent and often pilose; **spikelets** (1.3–) 1.5–1.9 (–2.2) mm long, approximately 1 mm wide, elliptic, pilose; **first glume** 0.5–1.0 mm long, typically 1/3 to 1/2 as long as the spikelet, obtuse to broadly acute.



Distribution and habitat. *Dichanthelium columbianum* is primarily found in very sandy soils in northeastern North America, the Great Lakes region, and sand prairie and savanna communities in the upper Mississippi watershed. The southernmost collections are from the few remaining sand prairies of southeastern Missouri which are derived from Pleistocene outwash of the Mississippi River. It often becomes a dominant species in sand prairie and dune systems of the upper Midwest where it commonly is found in association with *Lithospermum caroliniense*. The habitats of *D. columbianum* typically consist of dunes, pine woodlands, sand prairies, and open woods with extremely sandy soil profiles.

Representative specimens. **USA**. **Delaware**. New Castle Co.: 25 Jun 1823, *Commons 283* (US). Sussex Co.: 16 Jun 1926, *Fogg Jr. s.n.* (MO). **Illinois**. LaSalle Co.: 13 Jul 1901, *Chase 1602* (US). **Maryland**. Calvert Co.: 8 Jul 1934, *Chase 12270* (MU). **Massachusetts**. Nantucket Co.: 20 Sep 1907, *Bicknell s.n.* (NY). Plymouth Co.: 15 Sep 1916, *St. John 11755* (MU). **New Jersey**. Cape May Co.: 30 May 1897, *Bicknell s.n.* (NY). **New York**. Clinton Co.: 3 Jul 1902, *Eggleston 2843* (MU). Oneida Co.: 3 Jul 1945, *Crockett 7577* (MO). **Ohio**. Hocking Co.: 15 Jun 1982, *Cusick 21692* (MU). Lucas Co.: 19 Jun 1981, *Easterly 12688* (MU).

Dichanthelium columbianum varies widely in degree of pilosity or villosity but consistently possesses a short puberulence on all the internodes and sheaths of the vernal culm. This character, as well as spikelet, first glume, and ligule length are useful in separating it from *D. ovale*. The spikelet lengths of *D. columbianum* can approach those of *D. commonsianum*, in which case the ligule and glume length can be used to separate the two. When a pseudoligule is present in *D. columbianum* it is sparse and weakly differentiated from the true ligule, which can be easily detected with 30x magnification. Plants possessing a pseudoligule are typically more pilose or villose overall than those lacking a pseudoligule. Plants with more dense pilosity or villosity often possess pubescence all across the adaxial leaf surfaces while more sparsely pubescent plants may be nearly glabrous along the adaxial leaf surfaces.

Panicum addisonii is placed into synonymy under *Dichanthelium columbianum*. This is a unique placement, in that previous treatments have never directly associated *P. addisonii* with *D. columbianum*. Rather, it is usually treated under *D. commonsianum* or *D. ovale* evidently on the basis of having spikelets equal to or greater than 2 mm in length (Deam 1940; Fernald 1950; Freckmann & Lelong 2002; Freckmann & Lelong 2003; Gleason & Cronquist 1991; Gould & Clark 1978; Pohl 1947; Radford et al. 1968; Stone 1911). However, the holotype of *P. addisonii* has spikelets that range from 1.8–2.0 mm long which is well within the range of typical *D. columbianum* and outside the range for *D. commonsianum* or *D. ovale*. Furthermore, the length of its ligule and first glume better align it with *D. columbianum*. This confusion is thought to stem from the treatments of Hitchcock and Chase (1910, 1951) wherein the vernal culms of *P. addisonii* are referred to as being "similar to that of *P. commonsianum*." Stone (1911) was the first to subsume *addisonii* under *P. commonsianum*, referring to it as being a diminutive of the typical variety.

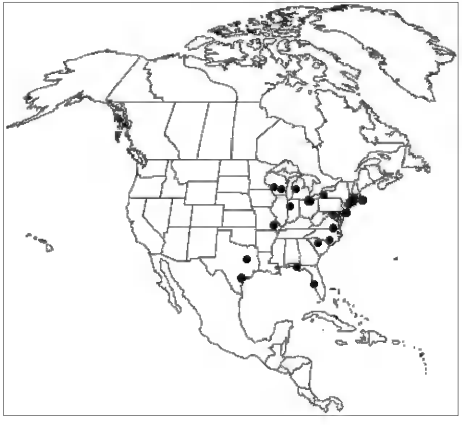
The treatments of Gould and Clark (1978) and Hitchcock and Chase (1910, 1950), included subspecific taxa under *Dichanthelium columbianum*. Hitchcock and Chase (1910, 1950) also maintained *P. tsugetorum* as a similar but separate species. The distinctions in these taxa were based largely on variations in spikelet length and pubescence type. Given the subtly of this variation, its lack of geographical or ecological correspondence and its consistency with levels of variation found in other groups, it is more satisfying to interpret these taxa as being within the range of variation of typical *D. columbianum* rather than maintaining undefinable infraspecific taxa. Extensive field familiarity with *D. columbianum* in the upper Midwest and northeastern North America may uncover some ecological or as yet unnoticed morphological differences worthy of recognition.

3. DICHANTHELIUM COMMONSIANUM (Ashe) Freckmann, Phytologia 39: 271. 1978. *Panicum commonsianum* Ashe, J. Elisha Mitchell Sci. Soc. 15: 55. 1898. *Panicum columbianum* var. *commonsianum* (Ashe) Dore, Naturaliste Canad. 103: 562. 1972. **TYPE: USA. New Jersey**. Cape May Co.: Cape May, collected in drifting sands along the coast, 29 Jun 1898, *Commons 341* (holotype: unknown; isotypes: NY!, US!).

Panicum deamii Hitchc. & Chase, Indiana Dept. Cons., Publ. 82: 284. 1929. **TYPE: USA. Indiana**. Lake Co.: collected on crest of low dune a quarter mi S of Pine, 21 Jun 1926, *Deam 43287* (holotype: US!).

Panicum euchlamydeum Shinners, Amer. Midl. Naturalist 32: 170. 1944. *Panicum commonsianum* var. *euchlamydeum* (Shinners) Pohl, Amer. Midl. Naturalist 38: 507. 1947. *Dichanthelium commonsianum* var. *euchlamydeum* (Shinners) Freckmann, Phytologia 39: 271. 1978. **TYPE: USA. Wisconsin**. Adams Co.: sandy slope, PH 7.5, 12 mi SE of Adams, 28 Jun 1942, *Shinners & Shaw 4415* (holotype: WIS!; isotypes: GH, US!).

Plants erect or ascending from a geniculate base, 10–60 cm tall; **internodes** double invested with short puberulent to pilose hairs below a villous pubescence (Figure 8d) or occasionally lacking the longer villous hairs on the middle and upper internodes (Figure 8c); **sheaths** double invested with short puberulent hairs below a pilose or villous pubescence (Figure 8d) or occasionally lacking the longer villous hairs on the middle and upper sheaths (Figure 8c), longer hairs 0.5–3.7 mm long when present; **ligule** 0.5–1.3 mm long; **pseudoligule** sparse or lacking (Figs. 7b or c); **leaf blades** spreading to ascending, 3–11 cm long, 3–7 (–10) mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface glabrate to villous, hairs absent along the longitudinal central third of the blade, abaxial surface with appressed puberulence; **panicles** 3–9 cm long, half as wide to as wide as long, puberulent; **spikelets** 2.2–2.7 mm long, approximately 1 mm wide, elliptic, pilose; **first glume** 0.9–1.8 mm long, typically 2/5 to 1/2 as long as the spikelet, obtuse to broadly acute.



Distribution and habitat. *Dichanthelium commonsianum* is found along the coastal plain of the eastern and southeastern USA from Massachusetts to Texas. Its distribution within the interior of North America is scattered and poorly understood but well-documented from the Great Lakes Region. It is reported from every state east of and including Arkansas, Kansas, and Iowa as well as throughout the Great Lakes region. The present study has verified interior North American collections from Missouri, Wisconsin, Indiana, and Ohio. Where found, *D. commonsianum* is associated with dry sandy soils of open woods, dunes and prairies.

Representative specimens. USA. Delaware. Sussex Co.: 18 Jun 1905, *Hitchcock 143* (MO). Sussex Co.: 24 Jun 1942, *McVaugh 6512* (MO). **Indiana**. Jasper Co.: 15 Jun 1947, *Friesner 21490* (MO). **Maryland**. Prince George's Co.: 25 Jul 1907, *Chase 146* (MO). **Massachusetts**. Barnstable Co.: 23 Jun 1918, *Fernald 16118* (MO). Barnstable Co.: 4 Aug 1918, *Fernald 16119* (MO). Dukes Co.: 5 Sep 1928, *Fogg Jr. 3875* (MO). **Missouri**. Scott Co.: 7 Sep 1993, *McKenzie 1294* (MO). **New Jersey**. Cape May Co.: 29 Jun 1899, *Commons 341* (US). Mercer Co.: 18 Aug 1866, *E.D. s.n.* (MO). Middlesex Co.: 9 Jul 1905, *MacKenzie 1485* (MO). Ocean Co.: 28 Jul 1907, *MacKenzie 2779* (MO). **New York**. Suffolk Co.: 19 Jul 1927, *Latham 4169* (MO). Suffolk Co.: 4 Aug 1956, *Van Schaak 3550* (MO). Suffolk Co.: 4 Aug 1956, *Van Schaak 3551* (MO). **Texas**. Robertson Co.: 30 Apr 1951, *Launchbaugh 397* (MO). **Wisconsin**. Adams Co.: 28 Jun 1942, *Shinners & Shaw 4415* (UW). La Crosse Co.: 18 Jun 1925, *Pammel 1334* (MO).

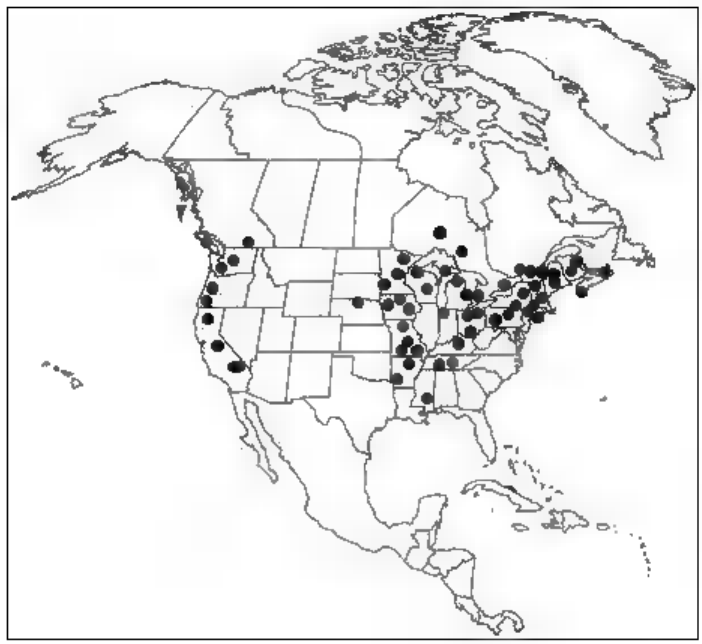
Dichanthelium commonsianum is most similar in morphology to *D. columbianum* and *D. ovale*. It can be distinguished from *D. columbianum* by its larger spikelets, shorter ligule, and longer first glume. It differs from *D. ovale* by the presence of puberulence on internodes and sheaths of the middle and upper culm which *D. ovale* lacks, as well as a longer ligule. There is also a strong tendency for the first glume of *D. commonsianum* to be slightly greater than half the overall spikelet length while the first glume of *D. ovale* is typically less than half the spikelet length. Some authors have included *P. addisonii* as synonymous or infra specific to *D. commonsianum*. For a discussion of this see notes under *D. columbianum*. *Panicum euchlamydeum* and *P. commonsianum* var. *euchlamydeum* are names once used in reference to Midwestern specimens of *D. commonsianum*. However, as is explained in Pohl's (1947) designation to variety, there is little value in maintaining var. *euchlamydeum* other than as representing the inland populations and there does not appear to be any morphological distinction other than a tendency for slightly more pubescence in Midwestern specimens. This is very much in line with finding in the present study as well in a general tendency for both *D. commonsianum* and *D. columbianum*.

4. **DICHANTHELIUM IMPLICATUM** (Scribn.) Kerg., Fl. Descript. France, Suppl. 5: 544. 1979. *Panicum implicatum* Scribn., Bull. Div. Agrostol. USDA 11: 43. 1898. *Panicum unciphyllum* var. *implicatum* (Scribn.) Scribn. & Merr., Rhodora 3: 123. 1901. *Panicum lindheimeri* var. *implicatum* (Scribn.) Fernald, Rhodora 23: 228. 1921. [1922]. *Panicum lanuginosum* var. *implicatum* (Scribn.) Fernald, Rhodora 36: 77. 1934. *Dichanthelium acuminatum* var. *implicatum* (Scribn.) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1126. 1978. 1979. *Panicum acuminatum* var. *implicatum* (Scribn.) Beetle, Phytologia 48: 192. 1981. *Dichanthelium acuminatum* subsp. *implicatum* (Scribn.) Freckmann & Lelong, Sida 20: 167. 2002. **TYPE: USA. Maine**. Cumberland Co.: Cape Elizabeth, on salt marshes, 26 Jul 1895, *Scribner s.n.* (holotype: US!; isotype: NY!).

Panicum occidentale Scribn., Ann. Rep. Missouri Bot. Gard. 10: 48. 1899. **TYPE: CANADA. British Columbia**. Nootka Sound, no date, *T. Haenke s.n.* (holotype: PR; isotype: MO!, US!).

Panicum pacificum Hitchc. & Chase, Contr. U.S. Natl. Herb. 15: 229. 1910. **TYPE: USA. California**. Shasta Co.: Castle Crag, one-fourth miles west of hotel, in moist places in woods, 3 Aug 1908, *A.S. Hitchcock 3070* (holotype: US!; isotype: NY!).

Plants erect or ascending from a geniculate base, 15–55 cm tall; **internodes** conspicuously to sparsely pilose to villose (Figure 8a); **sheaths** conspicuously to sparsely pilose to villose (Figure 8a), hairs 0.9–4.9 mm long; **ligule** 2.0–5.0 mm long (Figure 8a); **pseudoligule** lacking or indistinguishable from ligule; **leaf blades** spreading to ascending, 2.0–6.5 (–8) cm long, 2.0–6.0 (–8) mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface villous with the longest hairs often 3.0–6.0 mm long, abaxial surface pilose with the longest hairs often 0.8–2.0 mm long ; **panicles** 3–6 cm long, half as wide to as wide as long, densely to sparsely pilose; **spikelets** 1.3–1.7 mm long, approximately 0.7–1.0 mm wide, elliptic, pilose; **first glume** 0.3–0.7 mm long, typically equal or less than 1/3 the length of the spikelet, acute to broadly acute.



Distribution and habitat. *Dichanthelium implicatum* is found across southern Canada from British Columbia to Nova Scotia. In the USA it is found from Kansas north to Minnesota and east to Tennessee and Maine, plus the states of California, Oregon, and Washington. It is also listed as naturalized in southern Europe (Coste 1979), though this might actually be a misapplication of the name. The habitat of *D. implicatum* is highly variable and includes dry, open habitats with sandy soils such as dunes, sand prairies, and sandy or cherty woods. It is also occasionally found in bogs with acidic soils.

Representative specimens. **CANADA**. **Ontario**. Prince Edward Co.: 10 Jul 1947, *Gillett 1366* (MO). **USA**. **Arkansas**. Fulton Co.: 19 May 1909, *Bush 5637* (MO). **California**. Shasta Co.: 3 Aug 1908, *Hitchcock 3070* (US). **Iowa**. Johnson Co.: *Shimek s.n.* (MO). **Ohio**. Lucas Co.: 1 Jul 1997, *McCormac 5971* (MO). **Oregon**. 1871, *Hall s.n.* (MO). Curry Co.: 11 Jul 1919, *Peck 8795* (MO). **Maine**. Lincoln Co.: 13 Jul 1922, *Grover s.n.* (MO). Cumberland Co.: 25 Jul 1895, *Scribner* (US). **Massachusetts**. Berkshire Co.: 16 Jul 1917, *Churchill s.n.* (MO). Middlesex Co.: 27 Jun 1915, *Forbes s.n.* (MO). **Minnesota**. Anoka Co.: 7 Jul 1926, *Stoltz s.n.* (MO). Anoka Co.: 10 Aug 1926, *Stoltz s.n.* (MO). Chippewa Co.: 9 Jul 1982, *Gereau 1014* (MO). Itasca Co.: 30 Jun 1935, *Rosendahl & Maple 707* (MO). **New York**. Tompkins Co.: 18 Jul 1917, *Wiegand, Bechtel & Gershoy 7504*

(MO). **Rhode Island**. Providence Co.: *Olney s.n.* (MO). **Tennessee**. Coffee Co.: 20 Jun 1938, *Svenson 9230* (MO). **Vermont**. Caledonia Co.: *Seymour 18632* (MO). **Washington**. *Presl 3978* (MO). Chelan Co.: 25 Jun 1931, *Thompson 6928* (MO). **Wisconsin**. Bayfield Co.: 10 Jul 1938, *Fassett, Curtiss & Knowlton 19571* (MO).

The morphologies expressed by *Dichanthelium implicatum* and *D. lanuginosum* can be superficially similar. This is especially true when dealing with small *D. lanuginosum* and large *D. implicatum*. However, the vast majority of specimens of both species are distinct. *Dichanthelium implicatum* inhabits a much narrower ecological niche and is significantly more conservative than *D. lanuginosum*. Compared to *D. lanuginosum*, it is smaller in stature and the larger vernal leaves are less than 7.0 cm long. The longer hairs on the adaxial surface of vernal leaves average 3.2 mm in *D. implicatum* compared to 2.3 mm in *D. lanuginosum*. The longer hairs of the abaxial surface of vernal leaves average 0.9 mm long in *D. implicatum*, while in *D. lanuginosum* they average 0.6 mm. Furthermore, upon drying naturally the vernal leaves of *D. implicatum* often become strongly reflexed.

The similarities of the two species have prompted several authors (Braun 1967; Gleason & Cronquist 1991; Fernald 1950; Radford et al. 1968; Scoggan 1978; Steyermark 1963) to treat *Dichanthelium implicatum* as a variety of *D. lanuginosum*. Pohl (1947), in his treatment of Pennsylvania's grasses, followed the treatment of Hitchcock and Chase (1910) in which *P. lanuginosum* (often representing the nomenclatural misapplication of what is here treated as *D. acuminatum*) was restricted to the southeastern coastal plain. He then applied the name *P. implicatum* to what is here treated as *D. lanuginosum*. This treatment has since found its way into several floras in the Great Lakes Region (Swink & Wilhelm 1994; Voss 1972; Voss & Reznicek 2012) and no doubt added to the confusion of species concepts. It is also worth noting that *D. implicatum* is limited to the northern half of the geographical range of *D. lanuginosum*.

The type specimens of two species, *Panicum pacificum* and *P. occidentale*, described from western North America, are here treated as synonymous with *D. implicatum*. However, there are notable differences in these western populations, including wider leaves and differences in pubescence density that warrant further investigation. Many "non-type" specimens labeled "*P. pacificum*" and "*P. occidentale*" clearly belong to *D. lanuginosum* rather than *D. implicatum*. This is most likely due to erroneous identification rather than actual taxonomic confusion. *Dichanthelium implicatum* can superficially resemble *D. meridionale* but differs in its lack of a double vestiture (or at least no puberulence below the villose and pilose pubescence).

5. DICHANTHELIUM LANUGINOSUM (Ell.) Gould, *Brittonia* 26: 60. 1974. *Panicum lanuginosum* Ell., Sketch Bot. S. Carolina 1: 123. 1816. *Panicum dichotomum* var. *lanuginosum* (Ell.) Wood, Class-book of Botany 786. 1861. **TYPE: USA. Georgia**. unknown locality, unknown date, *Baldwin s.n.* (holotype: CHARL; fragment and photo, US!).

Panicum dichotomum var. *fasciculatum* Torr., Fl. N. Middle U.S. 145. 1824. *Panicum huachucae* var. *fasciculatum* (Torr.) F.T. Hubb., Rhodora 14: 171. 1912. *Panicum lindheimeri* var. *fasciculatum* (Torr.) Fernald, Rhodora 23: 228. 1921 [1922]. *Panicum lanuginosum* var. *fasciculatum* (Torr.) Fernald, Rhodora 36: 77. 1934. *Dichanthelium lanuginosum* var. *fasciculatum* (Torr.) Spellenb., Madrono 23: 145. 1975. *Dichanthelium acuminatum* var. *fasciculatum* (Torr.) Freckmann, Phytologia 48: 108. 1981. *Panicum acuminatum* var. *fasciculatum* (Torr.) Beetle, Phytologia 49: 40. 1981. *Dichanthelium acuminatum* subsp. *fasciculatum* (Torr.) Freckmann & Lelong, Sida 20: 167. 2002. **TYPE: USA. New Jersey**. unknown locality, in sandy fields, unknown date, *Torrey s.n.* (holotype: NY).

Panicum huachucae Ashe, J. Elisha Mitchell Sci. Soc. 15: 51. 1898. *Panicum lanuginosum* var. *huachucae* (Ashe) Hitchc., Rhodora 8: 208. 1906. **TYPE: USA. Arizona**. Huachuca Mountains, 1882, *Lemmon s.n.* (lectotype: US!, designated by Hitchcock & Chase, Contr. U.S. Natl. Herb. 15: 214. 1910).

Panicum tennesseense Ashe, J. Elisha Mitchell Sci. Soc. 15: 52. 1898. *Panicum lindheimeri* var. *tennesseense* (Ashe) Farw., Amer. Midl. Naturalist 11: 45. 1928. *Panicum lanuginosum* var. *tennesseense* (Ashe) Gleason, Phytologia 4: 21. 1952. **TYPE: USA. Tennessee**. La Vergne Co.: cedar glades, 7 Aug 1897, *Biltmore 7087* (holotype: location unknown; isotypes: NY!, US!).

Panicum nitidum var. *pilosum* Torr., Fl. N. Middle U.S. 146. 1824. *Panicum lindheimeri* subvar. *pilosum* (Torr.) Farw., Amer. Midl. Naturalist 11: 45. 1928. *Panicum lanuginosum* subvar. *pilosum* (Torr.) Farw., Pap. Michigan Acad. Sci. 26: 5. 1941. **TYPE: USA. New York**. unknown locality, in dry woods & c. New York, no date, unknown collector (holotype: NY?).

Panicum nitidum var. *ciliatum* Torr., Fl. N. Middle U.S. 146. 1824. **TYPE: USA. New Jersey**. unknown locality, no date, unknown collector (holotype: NY?).

Panicum funstonii Scribn. & Merr., Circ. Div. Agrostol. USDA 35: 4. 1901. **TYPE: USA. California**. Tulare Co.: collected on the bank of the Kaweak River at Three Rivers, 26 Jul 1891, *Coville & Funston 1286* (holotype: US!).

Panicum unciphyllum f. *prostratum* Scribn. & Merr., Rhodora 3: 124. 1901. **TYPE: USA. Maine**. York Co.: unknown locality, 26 Sep 1897, *Fernald s.n.* (holotype: US!).

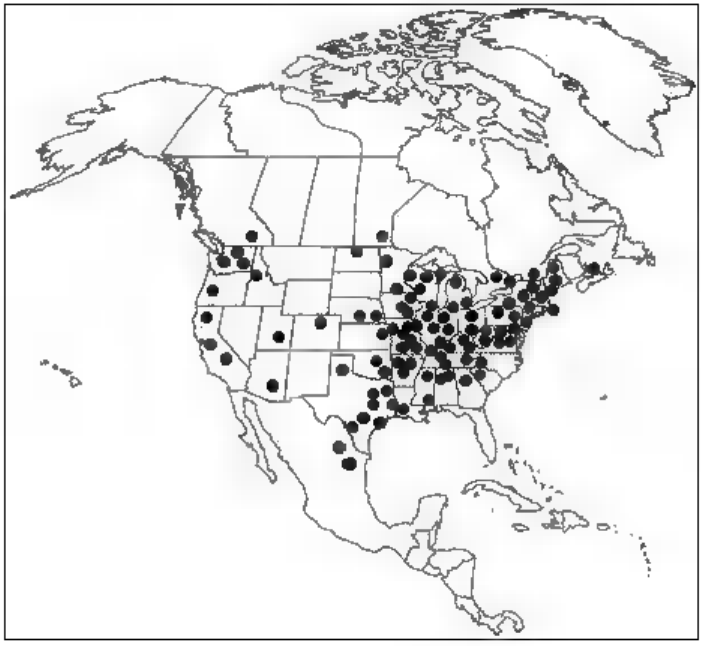
Panicum huachucae var. *silvicola* Hitchc. & Chase, Rhodora 10: 64–65. 1908. **TYPE: USA. District of Columbia**. Reno, 28 Jun 1904, *Chase 2400* (holotype: US!).

Panicum lindheimeri var. *septentrionale* Fernald, Rhodora 23: 227–228. 1921 [1922]. *Panicum lanuginosum* var. *septentrionale* (Fernald) Fernald, Rhodora 36: 77. 1934. *Dichanthelium acuminatum* var. *septentrionale* (Fernald) Mohlenbr., Ill. Fl. Illinois (ed. 2) Grasses: *Panicum* to *Danthonia*: 383. 2001. **TYPE: CANADA. New Brunswick**. Woodstock, river gravels and shingly border of thicket by the St. John River, 14 Jul 1916, *Fernald & Long 12527* (holotype: GH!).

Panicum brodiei H. St. John, Fl. SE Washington 51. 1937. **TYPE: USA. Washington**. Wawawai, Snake River, 1898, *Brodie s.n.* (holotype: WS!; isotype: US).

Plants erect or ascending from a geniculate base, 15–75 cm tall; **internodes** conspicuously to sparsely pilose to villose (occasionally velutinose) (Figure 8a); **sheaths** copiously to sparsely pilose to villose (Figure 8a), hairs (0.7–) 1.2–2.5 (–3.9) mm long, sheath margins ciliate; **ligule** (2.0–) 2.4–4.3 (–5.0) mm long (Figure 8a); **pseudoligule** lacking or indistinguishable from ligule; **leaf blades** spreading to ascending, 3–12 cm long, 3–12 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface glabrate to villous with the longest hairs typically 1.3–3.0 mm long, abaxial surface short pilose with the longest hairs typically 0.1–0.7 mm long; **panicles** 3–12 cm long, half as wide to as wide as long, densely to sparsely pilose; **spikelets** 1.3–1.9 mm long, approximately 0.7–1.1 mm wide, elliptic, pilose; **first glume** 0.3–0.7 mm long, typically equal or less than 1/3 the length of the spikelet, acute to broadly acute.

Distribution and habitat. *Dichanthelium lanuginosum* is found throughout North America but is most common in the central and eastern USA. Being the most generalist species within the section, *D. lanuginosum* inhabits a wide range of habitat types and is by far the most frequently encountered taxon in the section. It is most commonly associated with dry open habitats such as prairies, open woods, old fields, and forest edges.



Representative specimens. **CANADA**. **British Columbia**. Nelson Co.: 20 Jul 1939, *Thompson 14433* (MO). Vancouver Island, 26 Jun 1907, *Rosendahl 1931* (MO). **Ontario**. Pipineau Co.: 19 Jul 1947, *Dore 1051* (MO). **Quebec**. Missisquoi Co.: 10 Aug 1923, *Knowlton s.n.* (MO). **USA**. **Arkansas**. Benton Co.: 18 Jun 2002, *Thomas 1502* (private). **Arizona**. Mt. Huachuca, 1882, *Lemmon 2907* (US). **California**. Shasta Co.: 3 Aug 1908, *Hitchcock 136* (MO). Tulare Co.: 26 Jul 1891, *Coville & Funston 1286* (US). **District of Columbia**, 28 Jun 1904, *Chase 2400* (US). **Illinois**. Macon Co.: 12 Jun 1915, *Clokey 2440* (MO). Morgan Co.: 16 Jun 1999, *Hill 31708* (MO). Tazewell Co.: 23 Jun 1919, *Chase 3146* (MO). **Indiana**. Morgan Co.: 11 Jun 1934, *Friesner 7497* (MO). **Iowa**. Wapello Co.: 23 Jun 1939, *Hayden 925* (MO). **Kansas**. Douglas Co.: 15 Jun 1992, *McGregor 40533* (MO). **Kentucky**. Ballard Co.: 2 Jun 1923, *Anderson s.n.* (MO). **Louisiana**. Lake Charles Par.: 21 Apr 1906, *Hitchcock 1147* (MO). **Maine**. York Co.: 26 Sep 1897, *Fernald s.n.* (US). **Maryland**. Balto Co.: 21 Jun 1940, *Reed 2165* (MO). **Massachusetts**. Bristol Co.: 28 Jun 1961, *Seymour 19272* (MO). **Missouri**. Jasper Co.: 2 Jun 1912, *Palmer 3714* (MO). Jasper Co.: 9 Jun 1912, *Palmer 3753* (MO). **Nebraska**. Kearney Co.: 8 Jul 1918, *Hapeman s.n.* (MO). Nemaha Co.: 22 Jun 1972, *Churchill 200* (MO). **New Jersey**. Hunterdon Co.: 12 Jul 1915, *Fisher s.n.* (MO). **New York**. Tompkins Co.: 12 Jul 1913, *James 88* (MO). **Ohio**. Huron Co.: 20 Jun 1887, *Leonard 14* (MO). Scioto Co.: 27 Jun 1934, *Demaree 10756* (MO). **Oklahoma**. Creek Co.: 11 Jun 1939, *Harvey 808* (MO). LeFlore Co.: 17 May 1936, *Demaree 12712* (MO). **Oregon**. Lane Co.: 14 Jun 1928, *Peck 15950* (MO). **Pennsylvania**. Montgomery Co.: 15 Jun 1899, *MacElwee 544* (MO). Philadelphia Co.: no date, *Bigyn s.n.* (MO). **South Carolina**. Anderson Co.: May 1924, *Davis s.n.* (MO). **Texas**. Wheeler Co.: 25 Jun 1957, *Correll & Johnston 17045* (MO). **Utah**. San Juan Co.: 2 Jul 1933, *Maguire 5910* (MO). **Virginia**. Augusta Co.: 5 Jul 1937, *Allard 3170* (MO). **Washington**. Kittilas Co.: July 1898, *Sandberg & Leiberg 425* (MO). Okanogan Co.: Jul 1897, *Elmer 489* (MO). Whitman Co.: Jun 1898, *Brodie s.n.* (WS). **Wisconsin**. La Crosse Co.: 8 Jul 1975, *Ziegler 1656* (MO).

Dichanthelium lanuginosum exhibits considerable morphological variation across its range and in different habitats. In western North America the spikelets typically range from 1.7–1.9 mm long. In deeply shaded environments plants are more sparsely pubescent, the stems often become diffusely branched and the plants tend to sprawl. Also, the leaves often become thinner, wider, and darker green and the inflorescences are smaller and fewer-flowered. In dry habitats with high light the plants are smaller, more stiffly pubescent, more erect, and produce larger inflorescences with many spikelets. It is these latter specimens that most closely approach *D. implicatum* (see notes under *D. implicatum*). In moist, well-drained habitats plants are often sparsely pubescent on the sheaths and lack pubescence on the adaxial leaf surfaces. These plants have previously been called *P. tennesseense*, *P. lanuginosum* var. *tennesseense*, and *P. lanuginosum* var. *septentrionale*. However, given that the spectrum of pubescence is so closely associated with light and moisture, there seems to be little justification for any taxonomic recognition (see notes under *D. lindheimeri*).

Much of the taxonomic confusion surrounding *Dichanthelium lanuginosum* began with the regional misapplication of the name and its association with *D. acuminatum* (see discussion). Lelong (1984) claimed that the type specimens of *P. acuminatum* and *P. lanuginosum* are identical. However, the present study found several meaningful morphological differences between these types. The long, clearly single ligule and the absence of extensive marginal cilia on the leaf blades of *D. lanuginosum* easily distinguish it from *D. acuminatum* which has a short ligule (backed by a longer pseudoligule) and conspicuous marginal cilia along the leaf blades. While the geographical ranges of these two species do overlap along the coastal plain, *D. acuminatum* does not typically occur in the interior of North America.

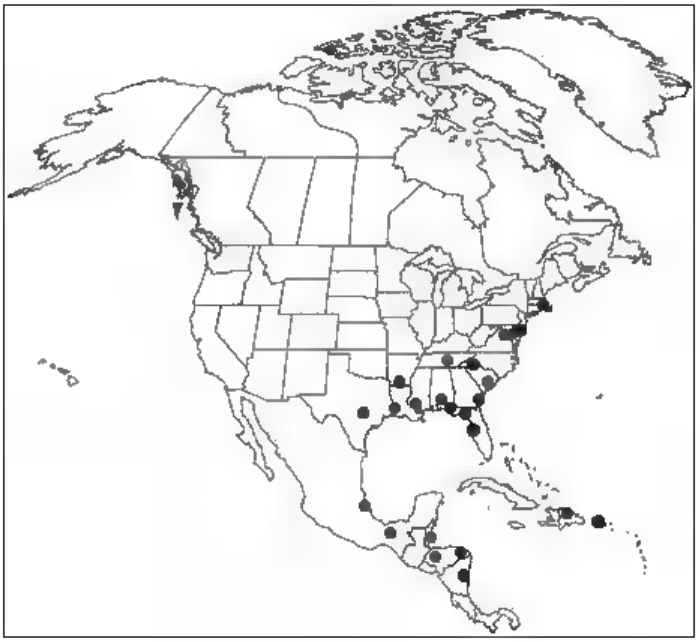
As the paragon of morphological and ecological plasticity, *Dichanthelium lanuginosum* is undoubtedly responsible for the majority of the confusion within sect. *Lanuginosa*. Having carefully observed this plasticity in the field for over a decade and a half, it appears to originate from highly involved breeding systems which may consist of varying combinations of selfing, outcrossing, and population level introgression with other seeming random members of the genus, often with little fidelity to other members of its own section. While the polymorphic nature of this species will confuse, humiliate, confound, and intimidate those unfamiliar with the degrees and directions of morphological expression to which it is capable of rising, given ample field experience its range of variability is certainly intelligible; though it takes more patience than most are willing to grant. As the requisite familiarity is acquired, one begins to pick up on patterns like the tendency of pubescence density and spikelet length to correlate to habitat wetness and acidity, as well as the situational reliability of the more variable character states. One thing is certain, *D. lanuginosum*, like many members of the section and even the genus, cannot be resolved in the mind of the taxonomist without extensive personal familiarity and a willingness to release it from the preconceived patterns and relationships one expects from less complicated groups.

6. DICHANTHELIUM LEUCOTHRIX (Nash) Freckmann, Phytologia 48: 101. 1981. *Panicum leucothrix* Nash, Bull. Torrey Bot. Club 24: 41. 1897. *Panicum acuminatum* var. *leucothrix* (Nash) Lelong, Brittonia 36: 271. 1984. *Dichanthelium acuminatum* subsp. *leucothrix* (Nash) Freckmann & Lelong, SIDA 20: 167. 2002. **TYPE: USA. Florida**. Lake Co.: low pine land at Eustis,16–31 Jul 1894, *Nash 1338* (holotype: NY!; isotypes: MO!, NCU, US).

Panicum parvispiculum Nash, Bull. Torrey Bot. Club 24: 347. 1897. **TYPE: USA. Georgia**. McIntosh Co.: collected at Darien Junction, 25–27 Jun 1895, *Small s.n.* (holotype: NY!; isotype: NY!, US).

Plants erect or ascending from a geniculate base, 10–50 cm tall; **internodes** short puberulent, occasionally also sparsely pilose on lower culms (Figs. 7c or d); **sheaths** puberulent, occasionally also pilose (Figs. 7c or d), longer hairs 0.3–1.6 mm long when present; **ligule** 2.2–4.0 mm long

(Figure 8a); **pseudoligule** absent or indistinguishable from ligule; **leaf blades** spreading to ascending, 2–7 cm long, 2.0–5.0 (–7.0) mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface puberulent to glabrate, abaxial surface puberulent; **panicles** 3–8 cm long, half as wide to as wide as long, puberulent and often pilose; **spikelets** 1.2–1.5 mm long, approximately 0.5–0.8 mm wide, elliptic, puberulent to pilose; **first glume** 0.3–0.5 mm long, typically 1/3 as long as the spikelet, obtuse to acute.



Distribution and habitat. *Dichanthelium leucothrix* is found along the coastal plain of North America from New Jersey to eastern Mexico and inland to Tennessee. It also occurs in Central America, northern South America, and the Caribbean. The habitat of *D. leucothrix* consists of wet to moist, often sandy, woodlands, pine savannas, and bogs.

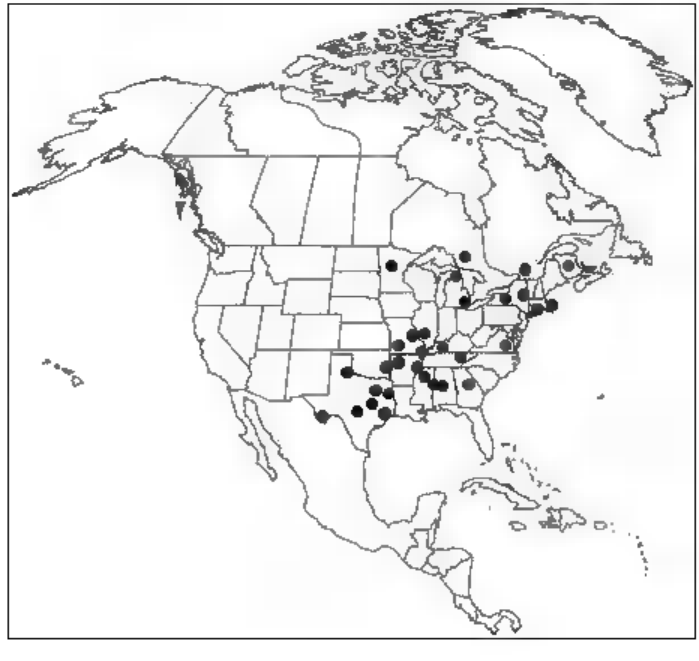
Representative specimens. **USA**. **Florida**. Fauquier Co.: 26 May 1903, *Tracy 8410* (MO). Hillsborough Co.: 2 Apr 1927, *O'Neill 2513* (MO). Lake Co.: 16–31 Jul 1894, *Nash 1338* (NY). **Georgia**. McIntosh Co.: 25–27 Jun 1895, *Small s.n.* (NY). **South Carolina**. Orangeburg Co.: 19 Aug 1905, *Hitchcock 118* (MO). **Tennessee**. Coffee Co.: 20 Jun 1938, *Svenson 9225* (MO). **Texas**. Robertson Co.: 30 Apr 1951, *Launchbaugh 394* (MO).

Dichanthelium leucothrix is one of the smaller members of the section and is similar to *D. wrightianum*, *D. longiligulatum*, and *D. meridionale* in leaf dimensions, presence of puberulence, and ligule length. This group is so distinct that it would not be difficult to justify them as a distinct section. Gould and Clark (1978) treated both *D. longiligulatum* and *D. wrightianum* as varieties of *D. acuminatum* and lumped *D. leucothrix* and *D. meridionale* with *D. acuminatum* var. *implicatum* (*D. implicatum* in present treatment). Given the absence of puberulence on the culms in *D. implicatum* and its larger spikelets, among other characters, Gould and Clark's lumping is not morphologically justified by the present study. Lelong (1984) and Freckmann and Lelong (2002, 2003) designated *D. leucothrix* as a subspecies of *D. acuminatum* (or *P. acuminatum*). Zuloaga et al. (1993b) placed *D. leucothrix* into synonymy under *P. acuminatum* var. *longiligulatum*. Compared to *D. acuminatum*, *D. leucothrix* has a distinctly different ligule (longer and lacking pseudoligule versus short ligule backed

by pseudoligule in *D. acuminatum*), does not possess extensive marginal cilia on vernal leaves, is much smaller in stature, has a close puberulence that *D. acuminatum* lacks, and has much smaller spikelets (averaging 1.3 mm versus 1.8 mm). *Dichanthelium leucothrix* differs from *D. longiligulatum* in possessing conspicuous pubescence on the sheaths and adaxial leaf surfaces of vernal culms.

7. DICHANTHELIUM LINDHEIMERI (Nash) Gould, Brittonia 26: 60. 1974. *Panicum lindheimeri* Nash, Bull. Torrey Bot. Club 24: 196. 1897. *Dichanthelium acuminatum* var. *lindheimeri* (Nash) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1127. 1978. *Panicum lanuginosum* var. *lindheimeri* (Nash) Fernald, Rhodora 36: 77. 1934. *Dichanthelium lanuginosum* var. *lindheimeri* (Nash) Harvill, Castanea 42: 177. 1977. *Panicum acuminatum* var. *lindheimeri* (Nash) Beetle, Phytologia 48: 193. 1981. *Dichanthelium acuminatum* subsp. *lindheimeri* (Nash) Freckmann & Lelong, Sida 20: 168. 2002. **TYPE: USA. Texas**. Comal Co.: springs, banks of Guadeloupe, near New Braunfels, May 1946, *Lindheimer 565* (holotype: NY! isotypes: MO!, NY!, US!).

Plants erect or ascending from a geniculate base, 15–100 cm tall; **internodes** glabrous to sparsely pilose; **sheaths** glabrous or lowermost sparsely pilose, margins ciliate; **ligule** 2.0–3.2 mm long (Figure 8a); **pseudoligule** absent; **leaf blades** spreading to ascending, 3–10 cm long, 3–12 mm wide, margins ciliate at the base of blade or eciliate, adaxial leaf surface glabrous to glabrate, abaxial surface glabrous; **panicles** 3–12 cm long, half as wide to as wide as long, glabrous to sparsely pilose; **spikelets** 1.3–1.7 mm long, approximately 0.7–1.0 mm wide, elliptic, pilose; **first glume** 0.3–0.6 mm long, typically equal or less than 1/3 the length of the spikelet, acute to broadly acute.



Distribution and habitat. *Dichanthelium lindheimeri* is found throughout central and eastern North America as well as California, Oregon, and New Mexico. In its southern range and in the Great Lakes region, *D. lindheimeri* is most commonly associated with sandy, ephemerally wet soils. In the central and northern regions of its range it is more commonly associated with floodplains, stream sides, and lake shores.

Representative specimens. **CANADA**. **New Brunswick**. Carleton Co.: 14 Jul 1910, *Fernald & Long 12527* (GH). **USA**. **Arkansas**. St. Francis Co.: 19 Jun 1956, *McDaniel 568* (MO). **Kentucky**. Caldwell Co.: 27 May 1970, *Conrad 1008* (MO). **Michigan**. Emmet Co.: 28 Jul 1922, *Gates 13354* (MU). Washtenaw Co.: 5 Jul 1935, *Hermann 6839* (MO). **Missouri**. Carter Co.: 16 May 2001, *Thomas 1416* (private). Howell Co.: 5 Jun 1999, *Thomas 678* (private). **New York**. Albany Co.: 23 Jun 1951, *Van Schaak 3230* (MO). Cayuga Co.: 25 Jul 1916, *Metcalf 5539* (MO). **Texas**. *Lindheimer 5651846* (NY). Gregg Co.: 18 Jun 1901, *Reverchon 2357* (MO).

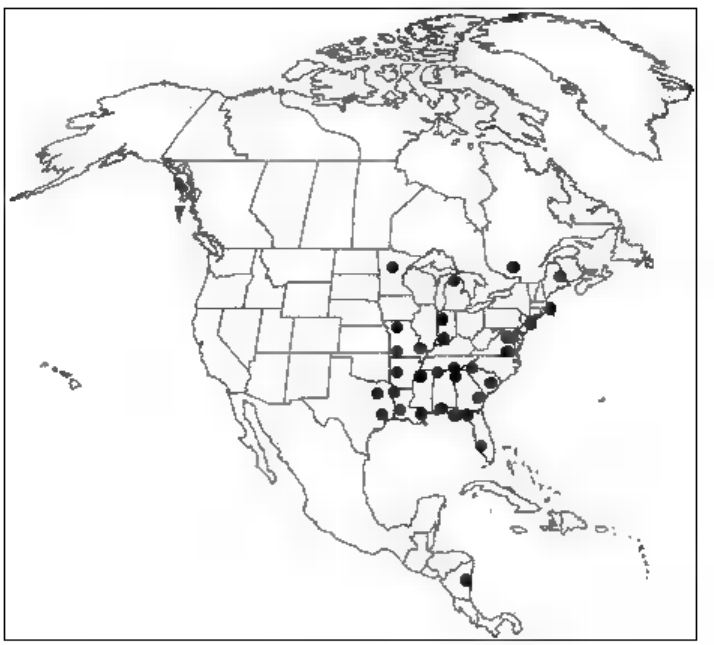
Superficially, *Dichanthelium lindheimeri* appears to be a glabrous variety or even a form of *D. lanuginosum*. In fact, many authors (Braun 1967; Gleason & Cronquist 1991; Fernald 1950; Radford et al. 1968; Scoggan 1978; Steyermark 1963) have placed it in this context. However, *D. lindheimeri* differs significantly from *D. lanuginosum* in several characters. The middle and upper internodes and sheaths of the vernal culms, the adaxial leaf surfaces (except for marginal cilia), and the central axis of the inflorescences are glabrous versus densely to sparsely pilose in *D. lanuginosum*. The margins at the base of vernal stem leaves in *D. lindheimeri* possess long hairs that are thin and crooked versus hairs that are rigid and straight in *D. lanuginosum*. The ligule of *D. lindheimeri* averages 2.4 mm long versus 3.1 mm long in *D. lanuginosum*. Although some overlap does occur, t-test for ligule length between these two species demonstrated a significant difference ($P<0.005$). Fourth, the typical habitats of *D. lindheimeri* are much wetter than *D. lanuginosum* and include stream and lake margins, sandy coastal marshes, and floodplains as opposed to the dry to mesic fields, prairies, open woods, and forest edges that *D. lanuginosum* inhabits. In all, *D. lindheimeri* and *D. lanuginosum* demonstrate a statistical difference ($P \leq 0.05$) in 15 of the 24 morphological characters sampled. Hitchcock and Chase (1910 and 1951) found these differences striking enough to align *D. lindheimeri* in a separate group (*Spreta*) than *D. lanuginosum*. Gould and Clark (1978) and Freckmann and Lelong (2002, 2003) treated *D. lindheimeri* as infraspecific in their widely encompassing *D. acuminatum*. Though neither of these treatments mentioned the distinctiveness of habitat as evidence for separation, the present study collected habitat information from 70 random herbarium labels of *D. lindheimeri*. Of these, two labels referred to the habitat as "dry," six labels provided no indication of site moisture and 62 labels (89 percent) indicated or implied saturated soil conditions. A similar review of *D. lanuginosum* labels indicated a predominance of dry soils.

Voss (1972) and Voss and Reznicek (2012) noted that along calcareous lake shores in the Great Lakes region, the morphological expression of what is here treated as *Dichanthelium lindheimeri* approximates that of *D. spretum* (a known acidophile). These plants have the overall habit of *D. spretum* coupled with the pubescence characters of *D. lindheimeri*. Furthermore, their vernal inflorescences are open panicles and their spikelets are not pointed, in contrast to *D. spretum* which has narrow inflorescences and pointed spikelets. Additionally, the inflorescences of *D. spretum* are conspicuously more densely flowered. These plants may represent an undescribed taxon within the group that is worthy of further investigation. Perhaps it is because of plants like these that Hitchcock and Chase (1910, 1951) placed *D. lindheimeri* in the informal group "*Spreta*" rather than "*Lanuginosa*." The more typical morphology of *D. lindheimeri* in Michigan seems to be restricted to the southern portion of the lower peninsula (Voss 1972; Voss & Reznicek 2012).

Dichanthelium lindheimeri can occasionally be difficult to differentiate from *D. longiligulatum*. See notes under *D. longiligulatum*, as well as the key above, for distinction between the two.

8. DICHANTHELIUM LONGILIGULATUM (Nash) Freckmann, Phytologia 48: 102.1981. *Panicum longiligulatum* Nash, Bull. Torrey Bot. Club 26: 574. 1899. *Dichanthelium acuminatum* var. *longiligulatum* (Nash) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1127. 1978. *Panicum acuminatum* var. *longiligulatum* (Nash) Lelong, Brittonia 36: 270. 1984. *Dichanthelium acuminatum* subsp. *longiligulatum* (Nash) Freckmann & Lelong, SIDA 20: 168. 2002. **TYPE: USA**. **Florida**. Franklin Co.: Apalachicola, 1892, *Vasey s.n.* (holotype: NY!; isotype: US!).

Plants erect or ascending from a geniculate base, 30–70 cm tall; **internodes** glabrous; **sheaths** glabrous to glabrate; **ligule** 1.8–3.1 mm long (Figure 8a); **pseudoligule** absent; **leaf blades** spreading to ascending, 2–8 cm long, 2.0–6.0 mm wide, adaxial surface glabrous, abaxial surface puberulent; **panicles** 3–8 cm long, half as wide to as wide as long, puberulent and often pilose; **spikelets** 1.1–1.5 mm long, approximately 0.5–0.8 mm wide, elliptic, puberulent to pilose; **first glume** 0.2–0.5 mm long, typically 1/3 as long as the spikelet, obtuse to acute.



Distribution and habitat. In North America *Dichanthelium longiligulatum* is most prevalent along the coastal plain from Mexico to New Jersey. Inland populations are known from several states. Its southern range extends through Central America and northern South America. It is also found throughout the Antilles. The habitat of *D. longiligulatum* consists of seasonally to perennially wet habitats of widely varying degrees of floristic integrity.

Representative specimens. **NICARAGUA**. **Comarca Del Cabo**. 12 Mar 1971, *Seymour 4576* (MO). **USA**. **Florida**. Franklin Co.: 1892, *Vasey s.n.* (NY). **Georgia**. Bulloch Co.: 10 Jun 1901, *Harper 839* (MO). Charlton Co.: 26 Aug 1902, *Harper 1575* (MO). **North Carolina**. Henderson Co.: July 1924, *Davis s.n.* (MO). **Tennessee**. Grundy Co. 23 Jun 1938, *Svenson 9119* (MO).

Dichanthelium longiligulatum can be distinguished from similar members of sect. *Lanuginosa* by its small stature, glabrous sheaths and the general absence of puberulent hairs on the abaxial surfaces of vernal stem leaves. Its overall stature is reminiscent of *D. spretum*, with which it was long aligned in "section" *Spreta* of Hitchcock and Chase (1910, 1951). However, the spikelets of *D. longiligulatum* are smaller than those of *D. spretum* and are not as acute at the apex, the inflorescence is not narrowly paniculate as in typical *D. spretum*, and *D. longiligulatum* has smaller leaf dimensions. *Dichanthelium longiligulatum* also resembles *D. leucothrix*, *D. meridionale*, and *D. wrightianum* but differs from these three in its lack of puberulence on the vernal sheaths, internodes, and adaxial leaf surfaces (mostly). Several authors (Freckmann & Lelong 2002; Freckmann & Lelong 2003; Gould & Clark 1978; Lelong 1984; Zuloaga et al. 1993b) have attempted to place *D. longiligulatum* as a variety or subspecies of *D. acuminatum*. However, *D. longiligulatum* differs strikingly from *D. acuminatum*. *Dichanthelium longiligulatum* has significantly smaller spikelets (1.1–1.5 mm vs. 1.6–2.1 mm), a longer ligule (1.8–3.1 mm vs. 0.4–1.3 mm), lacks the extensive marginal cilia that *D. acuminatum* has on its leaf blades, has glabrous sheaths, and occasionally possesses a light puberulence on the abaxial surfaces of vernal leaves. *Dichanthelium longiligulatum* also has much smaller leaves and is much more densely fascicled in the autumnal form than *D. acuminatum*. The combination of tall, often leaning, stems with dense fascicles of short leaves lends a "string of pearls" appearance. In herbarium specimens from subtropical and tropical regions *D. longiligulatum* often has a grey-green coloration.

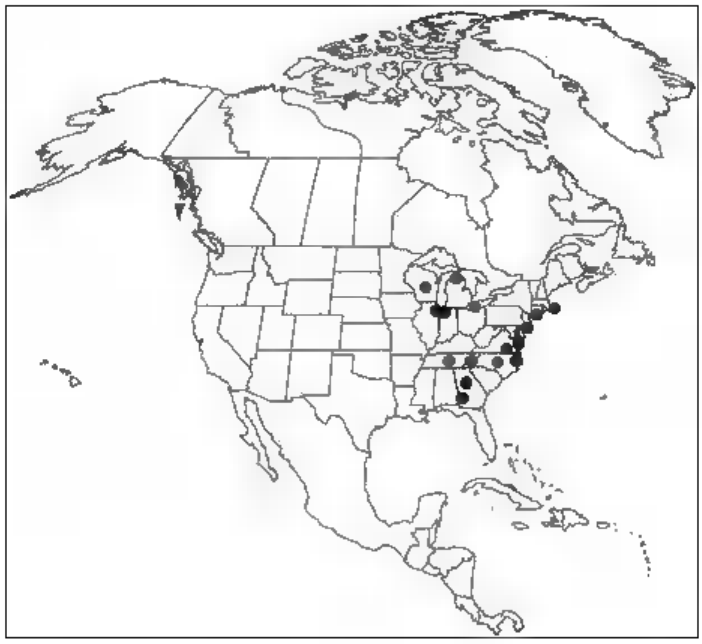
Dichanthelium longiligulatum can occasionally be difficult to differentiate from small leaved forms of *D. lindheimeri*. However, *D. lindheimeri* most often is the size and almost always has the proportions of *D. lanuginosum*. The autumnal form of *D. longiligulatum*, with its dense, nearly spherical, fascicles spaced along what is often a longer wiry stem, is strikingly different from either *D. lindheimeri* or *D. lanuginosum*.

9. DICHANTHELIUM MERIDIONALE (Ashe) Freckmann, Phytologia 39: 270–271. 1978. *Panicum meridionale* Ashe, J. Elisha Mitchell Sci. Soc. 15: 49. 1898. *Panicum unciphyllum* var. *meridionale* (Ashe) Scribn. & Merr., Rhodora 3: 123. 1901. *Panicum lindheimeri* subvar. *meridionale* (Ashe) Farw., Amer. Midl. Naturalist 11: 45. 1928. *Panicum lanuginosum* subvar. *meridionale* (Ashe) Farw., Pap. Michigan Acad. Sci. 26: 5. 1941. **TYPE: USA. North Carolina**. Burke Co.: Blue Ridge, Jun 1893, *Ashe s.n.* (lectotype: US!, designated by Hitchcock and Chase, Contr. U.S. Natl. Herb. 15: 210. 1910).

Panicum albemarlense Ashe, J. Elisha Mitchell Sci. Soc. 16: 84. 1900. *Panicum meridionale* var. *albemarlense* (Ashe) Fernald, Rhodora 36: 76. 1934. *Dichanthelium meridionale* var. *albemarlense* (Ashe) Mohlenbr., Ill. Fl. Illinois (ed. 2): 381. 2001. **TYPE: USA. North Carolina**. Beaufort or Hyde Co.: unknown locality, in open woods, well drained, 26 May 1899, *Ashe s.n.* (lectotype: US!, designated by Hitchcock and Chase, Contr. U.S. Natl. Herb. 15: 220. 1910).

Panicum microphyllum Ashe, J. Elisha Mitchell Sci. Soc. 15: 61. 1898. **TYPE: USA. North Carolina**. Orange Co.: "June," *Ashe s.n.* (NY 381644, designated by LeBlond 2015; duplicate US 2383610-fragm. ex NY 381644).

Plants erect or ascending from a geniculate base, 5–45 cm tall; **internodes** double invested with both short puberulent and long pilose pubescence (Figure 8d); **sheaths** double invested with short puberulent hairs below a pilose or villous pubescence (Figure 8d), longer hairs 1.7–3.8 mm long; **ligule** 1.7–4.0 mm long (Figs. 7a or d); **pseudoligule** absent or intermeshed with ligule; **leaf blades** spreading to ascending, 1.5–7.0 cm long, 2.0–6.0 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface long pilose, abaxial surface puberulent and occasionally pilose; **panicles** 1.5–5.0 cm long, half as wide to as wide as long, puberulent and pilose; **spikelets** 1.3–1.6 mm long, approximately 0.7–0.9 mm wide, elliptic, puberulent to pilose; **first glume** 0.3–0.8 mm long, typically 1/3 as long as the spikelet, obtuse to acute.



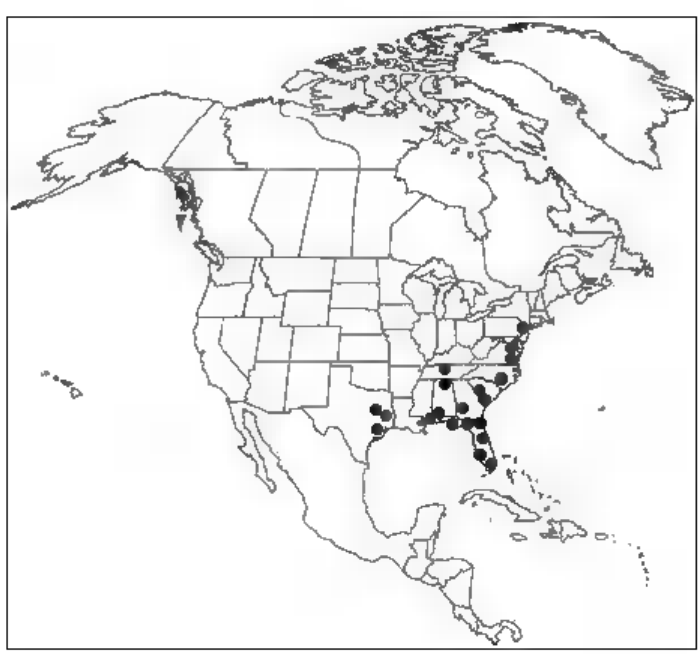
Distribution and habitat. *Dichanthelium meridionale* ranges from Nova Scotia to Minnesota and south to Alabama and Georgia with a predilection for coastal areas. It grows in high quality, seasonally wet or perennially moist sandy soils of open woods, clearings, prairies, and shores.

Representative specimens. **USA**. **Massachusetts**. Barnstable Co.: 3 Jul 1931, *Churchill s.n.* (MO). **New York**. Suffolk Co.: 22 Jun 1916, *Chase 526* (MO). **North Carolina**. Beaufort Co.: *Ashe s.n.* (US). Burke Co.: *Ashe s.n.* (US). Orange Co.: *Ashe s.n.* (NCU). Orange Co.: *Ashe s.n.* (MO). **Tennessee**. Cannon Co.: 20 May 1974, *Kral 52796* (MO). Cannon Co.: 20 May 1974, *Kral 52800* (MO). **Virginia**. Prince George Co.: 30 May 1965, *Freckmann 1565* (MO). Greensville Co.: 18 Jun 1941, *Fernald & Long 12940* (MO).

Gould and Clark (1978) placed *Dichanthelium meridionale* under synonymy with *D. acuminatum* var. *implicatum*. Freckmann and Lelong (2002, 2003) made no mention of where *D. meridionale* fits into their revisions to sect. *Laruginosa*, but the "Names and Synonyms" section of Volume 25 of the "Flora of North America" lists it as a synonym of *D. acuminatum* subsp. *implicatum*. Neither treatment has provided any direct reason for placing *D. meridionale* into synonymy under *D. acuminatum*. *Dichanthelium meridionale* differs from *D. implicatum* in having a pronounced double vestiture of puberulent hairs beneath a longer pilosity. This is best demonstrated on the sheaths, internodes, and abaxial leaf surfaces of the vernal stem. Because of its extensive double vestiture, *D. meridionale* is often confused with *D. columbianum*. The two can easily be distinguished by the smaller ligule of *D. columbianum* (0.7–1.5 versus 1.7–4.0 mm long). With its small stature, unique combination of pubescence, and affinity to high quality natural areas, *D. meridionale* is one of the more distinctive members of the section.

10. DICHANTHELIUM OVALE (Ell.) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1114. 1978.
Panicum ovale Ell., Sketch Bot. S. Carolina 1: 123. 1816. **TYPE: USA. Georgia**. Camden Co.: St. Mary's, no date, *Baldwin s.n.* (holotype: CHARL; fragment and photo US!).
Panicum ciliiferum Nash, Bull Torrey Bot. Club 24: 195–196. 1897. **TYPE: USA. Florida**. Lake Co.: in the vicinity of Eustis, high pine land, 12–31 Mar 1894, *Nash 147* (holotype: NY!; isotypes: US! MO!).
Panicum erythrocarpon Ashe, J. Elisha Mitchell Sci. Soc. 16: 90. 1900. **TYPE: USA. North Carolina**. New Hanover Co.: shady slopes on the sand hills one mile north of Wilmington, 17 May 1899, *Ashe s.n.* (holotype: NCU!; isotypes: NCU, US!).
Panicum wilmingtonense Ashe, J. Elisha Mitchell Sci. Soc. 16: 86. 1900. **TYPE: USA. North Carolina**. New Hanover Co.: shady slopes on the sand hills one mile north of Wilmington, 17 May 1899, *Ashe s.n.* (holotype: NCU!; isotype: US!).
Panicum benneri Fernald, Rhodora 46: 2–3. 1944. **TYPE: USA. New Jersey**. Hunterdon Co.: old field along the Delaware River ca. 1.5 miles east of Raven Rock, 7 Jun 1941, *Benner 9635* (holotype: GH!; isotype: GH!, US, PH).

Plants erect or ascending from a geniculate base, 20–60 cm tall; lower-most **internodes** double invested with short puberulent to pilose hairs below a villous pubescence or occasionally lacking the longer villous hairs, the middle and upper internodes ascending to appressed pilose or villose, lacking the short puberulence of the lower internodes; lowermost **sheaths** double invested with short puberulent hairs below a pilose or villous pubescence (Figure 8d), upper sheaths pilose to villose and lacking puberulent hairs (Figure 8a), longer hairs 0.2–2.7 mm long; **ligule** 0.2–0.7 (–1.0) mm long (Figs. 7b or c); **pseudoligule** 2.0–4.0 mm long when present; **leaf blades** spreading to ascending, 3–11 cm long, 4–10 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface villose to glabrate, hairs absent along the central third of the blade, abaxial surface with appressed puberulence or glabrate; **panicles** 4–9 cm long, half as wide to as wide as long, puberulent; **spikelets** 2.1–2.9 mm long, approximately 1.0 mm wide, elliptic, pilose; **first glume** 0.7–1.6 mm long, typically 2/5 to 1/2 as long as the spikelet, obtuse **to broadly acute.**



Distribution and habitat. *Dichanthelium ovale* is found along the coastal plain of North America from Massachusetts to Texas and south into Central America. It is likely known from the islands of the Antilles. Its habitat consists of sandy, open woods and clearings.

Representative specimens. **USA**. **Alabama**. Dekalb Co.: 27 May 1974, *Kral 53036* (MO). Henry Co.: Oct 1972, *Kral 48982* (MO). Monroe Co.: 31 May 1972, *Kral 46998* (MO). **Florida**. May 1909, *Chapman s.n.* (MO). Duval Co.: 24 Apr 1897, *Curtiss 5866* (MO). Franklin Co.: 16 May 1969, *Godfrey 69494* (MO). Lake Co.: 17–31 March 1894, *Nash 147* (US). Lake Co.: 13 May 1900, *Curtiss 6616* (MO). Lee Co.: Jul–Aug 1900, *Hitchcock 474* (MO). Liberty Co.: 19 Oct 1977, *Kral 61184* (MO). **Georgia**. *Romer s.n.* (MO). Lee Co.: 11 May 1940, *Duncan 2317* (MO). **Massachusetts**. *Chapman s.n.* (MO). **New Jersey**. Burlington Co.: 16 Jun 1900, *Parker s.n.* (MO). Burlington Co.: 18 Jun 1933, *Herman 4465* (MO). Hunterdon Co.: 7 Jun 1941, *Benner 9635* (GH). Monmouth Co.: 26 Jun 1929, *Churchill s.n.* (MO). **North Carolina**. Cumberland Co.: 16 May 1976, *Solomon s.n.* (MO). New Hanover Co.: 17 May 1899, *Ashe s.n.* (US). Sampson Co.: 17 May 1966, *Freckmann 2114* (MO). **South Carolina**. Aiken Co.: 1 Jun 1867, *Ravenel s.n.* (MO). Aiken Co.: 11 Jun 1867, *Ravenel* (MO). Aiken Co.: 20 May 1899, *Eggert s.n.* (MO). Aiken Co.: 21 May 1899, *Eggert s.n.* (MO). Aiken Co.: Oct 1967, *Ravenel s.n.* (MO). Beaufort Co.: 27 May 1916, *Chase 7115* (MO). Beaufort Co.: 6 May 1917, *Churchill s.n.* (MO). **Tennessee**. Wilson Co.: Jun 1881, *Gattinger 7387* (MO). **Virginia**. Nansemond Co.: 26–28 Jul 1939, *Fernald & Long 10505* (MO). Northumberland Co.: 1 Jun 1946, *Reed 5136* (MO).

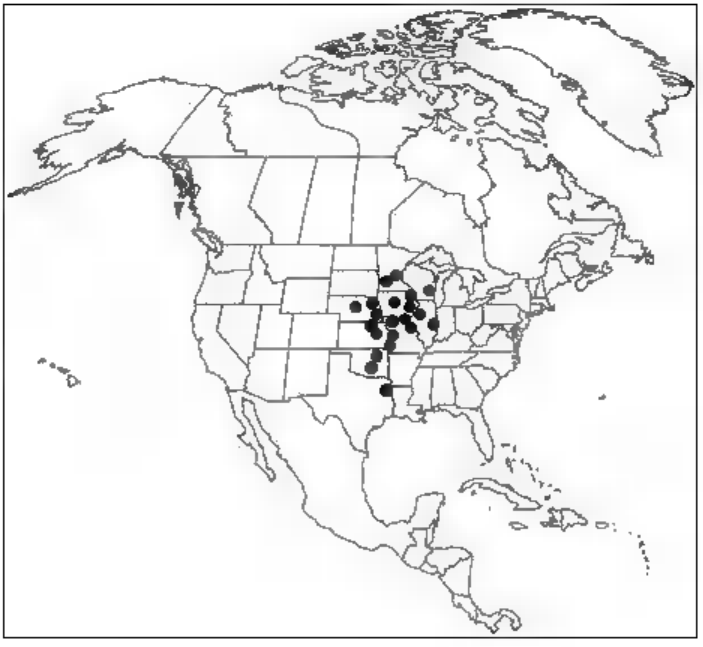
All treatments involving what is now sect. *Lanuginosa* have kept *Dichanthelium ovale* as a distinct species. However, other taxa within the group have often been assigned as infraspecific in *D. ovale*. *Panicum addisonii* (treated under *D. columbianum* in the present work) has often been treated as a variety of *D. ovale*. The treatment of Freckmann and Lelong (2002, 2003) relegated what is here treated as *D. villosissimum* and *D. praecocius* to subspecies of *D. ovale*. Lelong (1984) also treated *D. villosissimum* under *D. ovale* (as *Panicum ovale* var. *villosum*). Interestingly, these are the only two treatments to bridge the gap between the traditional groups *Lanuginosa* and *Columbiana* (now both sect. *Lanuginosa*) of Hitchcock and Chase (1910, 1951) by combining taxa from each group. Lelong (1984) justified this based on Gould and Clark's (1978) placement of *P. addisonii* (including *D. commonsianum*) as a variety of *D. ovale* by stating that *D. villosissimum* is more like *P. addisonii* than *D. ovale* therefore *D. villosissimum* should probably also be a variety of *D. ovale*. However, the present study shows that *P. addisonii* is better placed under *D. columbianum* (for discussion of this see *D. columbianum*) and that *D. villosissimum* and *D. praecocius* demonstrate ample distinction for recognition as separate species.

Dichanthelium ovale differs from both *D. villosissimum* and *D. praecocius* in having larger spikelets, larger first glumes, and a puberulent pubescence on the lower sheaths and internodes of the vernal culms. As with many members of the traditional group *Columbiana*, the hairs on the adaxial surfaces of vernal stem leaves of *D. ovale* are restricted to the blade edges (or lacking altogether), thus the central third of the adaxial leaf surface is glabrous. This is in stark contrast with both *D. villosissimum* and *D. praecocius*, which possess a uniform pubescence across the adaxial leaf surfaces of vernal stem leaves. Furthermore, the true ligule of *D. praecocius* is significantly larger (typically 2.5–4.0 mm) than either *D. villosissimum* (0.3–1.3 mm) or *D. ovale* (0.2–0.7 mm). Freckmann and Lelong (2002) also saw fit to designate *P. pseudopubescens* as a subspecies of *D. ovale*. While this taxon has a convoluted nomenclature, the present study demonstrates that, at least for now, it is best placed in the synonymy with *D. villosissimum*. For additional discussion of *P. pseudopubescens* see notes under *D. villosissimum*. Nomenclatural confusion aside, the only taxon that is likely to be confused with *D. ovale* is *D. commonsianum*. For a discussion on the differences between these two closely related taxa see notes under *D. commonsianum*.

Panicum malacon has often been associated with *D. ovale* (Freckmann & Lelong 2003; Gould & Clark 1978; Hansen & Wunderlin 1988). The present treatment finds that *P. malacon* possesses little morphological resemblance to any members of sect. *Lanuginosa*. Upon review of the type specimen, it is better placed with members of sect. *Angustifolia*.

11. DICHANTHELIUM PRAECOCIUS (Hitchc. & Chase) Mohlenbr., Ill. Fl. Illinois (ed. 2) Grasses: *Panicum* to *Danthonia*: 383. 2001. *Panicum praecocius* Hitchc. & Chase, Rhodora 8: 206–207. 1906. *Panicum lanuginosum* var. *praecocius* (Hitchc. & Chase) Dore, Le Naturaliste Canadien 103: 562. 1976. *Dichanthelium villosissimum* var. *praecocius* (Hitchc. & Chase) Freckmann, Phytologia 39: 270. 1978. *Dichanthelium ovale* subsp. *praecocius* (Hitchc. & Chase) Freckmann & Lelong, Sida 20: 170. 2002. *Panicum ovale* var. *praecocius* (Hitchc. & Chase) Wipff, Sida 20: 1044. 2003. **TYPE: USA. Illinois**. Stark Co.: near Wady Petra, dry bank, 30 Jun 1900, *Chase 649* (holotype: US!; isotypes: NY!, GH!).

Plants erect or ascending from a geniculate base, 10–50 cm tall; **internodes** conspicuously to sparsely pilose to villose (Figure 8a), hairs ascending to appressed; **sheaths** copiously pilose to villose (Figure 8a), the hairs often darkened in hue, erect to ascending and (1.8–) 2.8–4.0 (–4.8) mm long; **ligule** (1.8–) 2.5–4.0 (–4.7) mm long (Figure 8a); **pseudoligule** lacking or indistinguishable from ligule; **leaf blades** ascending, 5–9 cm long, 3–7 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface villose often with dark hued hairs, abaxial surface pilose; **panicles** 4–6 cm long, half as wide to as wide as long, densely to sparsely pilose, axillary inflorescences produced soon after terminal inflorescences; **spikelets** (1.6–) 1.8–1.9 (–2.1) mm long, approximately 0.8–1.2 mm wide, elliptic, pilose; **first glume** 0.6–1.0 mm long, typically 1/3 to 1/2 the length of the spikelet, acute to broadly acute.



Distribution and habitat. *Dichanthelium praecocius* ranges from southwestern Ontario to North Dakota in the north, east to Illinois, and south to Texas and northwest Arkansas. The habitat of *D. praecocius* primarily consists of upland prairies but rarely extends to open woodlands within or near a prairie matrix. It is endemic to the Tallgrass Prairie Ecoregion. *Dichanthelium praecocius* exhibits high fidelity to intact, undisturbed natural communities and is a good indicator of habitat integrity.

Representative specimens. **USA**. **Arkansas**. Benton Co.: *Plank s.n.* (MO). Benton Co.: 18 Jun 2002, *Thomas 1501* (MO). **Illinois**. Champaign Co.: 20 Jun 1906, *Gleason s.n.* (MO). Stark Co.: 30 Jun 1900, *Chase 649* (US). Stark Co.: 10 Jun 1906, *Chase 671* (MO). **Iowa**. Story Co.: 18 Jun 1865, *Freckmann 1927* (MO). **Kansas**. Cloud Co.: 15 Jun 1937, *Fraser 796* (MO). **Minnesota**. Renville Co.: 19 Jun 1940, *Moore 13054* (MO). Sherburne Co.: 6 Jul 1999, *Swanson 1383* (MO). **Missouri**. Barton Co.: 16 Jun 1990, *Yatskievych & Yatskievych 90-147* (MO). Callaway Co.: 12 Sep 1937, *Steyermark 26220* (MO). Clark Co.: 8 Jul 1909, *Bush 5909A* (MO). Dade Co.: 9 Aug 2000, *Thomas 1307* (MO). Dent Co.: 30 Jun 1929, *Kellogg 15078* (MO). Jasper Co.: 5 Jun 1909, *Palmer 2157B* (MO). Jasper Co.: 5 Jun 1909, *Palmer 2144* (MO). **Nebraska**. Cuming Co.: 31 May 1975, *Churchill 5528* (MO). Lancaster Co.: 15 Jun 1900, *Hedgcock s.n.* (MO). Lancaster Co.: 4 Jun 1973, *Churchill 941* (MO). Saunders Co.: 25 Jun 1974, *Churchill 3588* (MO). Stanton Co.: 15 Jun 1976, *Churchill 7709* (MO). Winneskiek Co.: 12 Jun 1933, *Tolstead s.n.* (MO). **Oklahoma**. Creek Co.: 11 May 1895, *Bush 1220* (MO). Murray Co.: *Waterfall 6021* (MO). **Texas**. Harrison Co.: 8 Aug 1907, *Bush 632* (MO). **Wisconsin**. Columbia Co.: 14 Jun 1942, *Shinners & Shaw 4361* (MO).

Dichanthelium praecocius is unique in the timing of its secondary inflorescence production. Where other *Dichanthelium* produce terminal inflorescences early in the growing season followed by axillary inflorescences late in the season, *D. praecocius* produces both terminal and axillary inflorescences early and continues to produce axillary inflorescences throughout the growing season. In overall morphology it is most similar to *D. lanuginosum* and *D. implicatum*. It differs from both in having larger spikelets, a longer first glume, longer hairs on the vernal sheaths, and a unique distribution of ligule hairs (see key). *Dichanthelium praecocius* also tends to have narrower vernal leaves which are more ascending or appressed than either *D. lanuginosum* or *D. implicatum*. The hairs on the sheaths and adaxial surfaces of *D. praecocius* often have a dark coloration and seem to be more brittle than other species. Because of this, late in the growing season the plants take on a very "messy" appearance with numerous dark, broken and bent hairs. *Dichanthelium praecocius* tends to have smaller vernal inflorescences with fewer nodes on the central axis (average of 7.7) than other members of the section.

When populations of *Dichanthelium lanuginosum* and *D. praecocius* occur sympatrically, as they often do in prairie habitats, they occasionally exhibit what is easily interpreted as introgression wherein the population of *D. lanuginosum* takes on elements of the stature and pubescence characteristics of *D. praecocius*. This may seduce one into the belief that this somehow weakens the species boundaries between the two were it not for the fact that one can readily find *D. lanuginosum* forming the same relationships with *D. oligosanthes* var. *scribnerianum*, *D. linearifolium*, *D. sphaerocarpon*, and *D. scoparium*; four unquestionably distinct species. This is an example of the complex breeding systems and exceptional behaviors that these species exhibit and that necessitate a more flexible and, for lack of a better term, lenient species concept than is usually applied to the genus in general and the section in particular.

Gould and Clark (1978) combined *Dichanthelium praecocius* and *D. villosissimum* and treated the combination as a variety of *D. acuminatum* (*D. acuminatum* var. *villosum*). Freckmann (1978) treated *D. praecocius* as a variety of *D. villosissimum*. Given the present morphological examination, there does not appear to be any infraspecific relationship between any of these three

taxa. Both *D. acuminatum* and *D. villosissimum* have ligules less than 1.4 mm long while that of *D. praecocius* exceeds 1.8 mm long. Although *D. acuminatum* and *D. villosissimum* have similar ligule lengths, the ciliate margins and smaller spikelets of *D. acuminatum* and the dramatically longer vernal sheath pubescence of *D. villosissimum* clearly set each apart. Freckmann and Lelong (2002, 2003) treated both *D. praecocius* and *D. villosissimum* as subspecies of *D. ovale*. For discussion involving these taxa, see notes under *D. ovale*. Populations at the northern and eastern edges of the range of *D. praecocius* are composed of larger, more densely pubescent plants that approximate *D. villosissimum* in terms of gross morphology. Said plants can be distinguished by their longer ligules and smaller spikelets. Plants in the central and western portions of the range have narrower, more appressed leaves and are less densely pubescent overall. These plants more closely resemble *D. implicatum* from which they can be distinguished by having larger spikelets and glumes and longer vernal sheath pubescence (see key for details).

12. DICHANTHELIUM SPRETUM (Schult.) Freckmann, Phytologia 48: 102. 1981. *Panicum spretum* Schult., Mantissa 2: 248. 1824. *Dichanthelium lanuginosum* var. *spretum* (Schult.) Harvill, Castanea 42: 177. 1977. *Dichanthelium acuminatum* subsp. *spretum* (Schult.) Freckmann & Lelong, Sida 20: 168. 2002. **TYPE: USA**. New England, unknown locality, moist ground, no date, *Muhlenberg 184* (holotype: PH; fragment and photo, US!).

Panicum nitidum var. *densiflorum* Rand & Redfield, Fl. Mt. Desert Isl. 174. 1894. *Dichanthelium acuminatum* var. *densiflorum* (Rand & Redfield) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1127. 1978. *Panicum acuminatum* var. *densiflorum* (Rand & Redfield) Lelong, Brittonia 36: 270. 1984. **TYPE: USA. Maine**. Hancock Co.: Mount Desert, shores of Ripples Pond, 28 Jul 1892, *Rand s.n.* (holotype: GH!; fragment, US).

Panicum eatoni Nash, Bull. Torrey Bot. Club 25: 84. 1898. **TYPE: USA. New Hampshire**. Seabrook, unknown locality, 1897, *Eaton s.n.* (holotype: NY!; fragment and photo, US!).

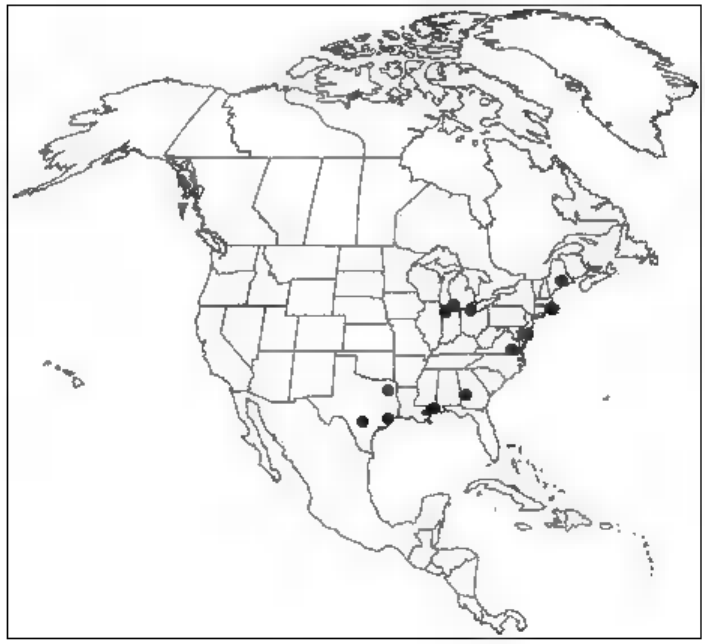
Panicum paucipilum Nash, Bull Torrey Bot. Club 26: 573. 1899. **TYPE: USA. New Jersey**. Cape May Co.: at Wildwood, 30 & 31 May 1897, *Bicknell s.n.* (holotype: NY!; isotypes: NY!, US!).

Panicum octonodum Smith, USDA Div. Agrost. Bull. 17: 73. 1899. *Panicum nitidum* var. *octonodum* Scribn. & Merr., USDA Div. Agrost. Bull. 24: 34. 1901. **TYPE: USA. Texas**. Waller Co.: Waller County line near Harris County, Jun 1898, *Thurow 6* (holotype: US!).

Plants erect or ascending from a geniculate base, 30–120 cm tall; **internodes** glabrous; **sheaths** glabrous; **ligule** 1.7–3.0 mm long (Figure 8a); **pseudoligule** absent; **leaf blades** spreading to ascending, 3–14 cm long, 3.0–9.0 mm wide, glabrous adaxially and abaxially; **panicles** 6–12 cm long, less than half as wide as long, glabrous to sparsely pilose; **spikelets** 1.3–1.9 mm long, approximately 0.7–0.9 mm wide, elliptic to narrowly ovate, pubescent or rarely glabrous; **first glume** 0.3–0.7 mm long, typically 1/4 to 1/3 as long as the spikelet, obtuse to acute.

Distribution and habitat. *Dichanthelium spretum* is found on the coastal plain of North America from Nova Scotia to Texas. It is also found within the Great Lakes Region, where it occurs with other coastal plain disjuncts. It is an acidophile and primarily inhabits saturated to seasonally saturated sandy to peaty soils along lake and bog margins or within coastal marshes and savannas. It is intolerant of natural community disturbance and may be of conservation concern where it is found.

Representative specimens. **USA. Texas**. Waller Co.: Jun 1898, *Thurow 6* (US). **New Jersey**. Cape May Co.: 30–31 1897, *Bicknell s.n.* (NY). **New Hampshire**. Rockingham Co.: 1897, *Eaton s.n.* (NY). **Massachusetts**. Middlesex Co.: 29 Jun 1896, *Blankinship 109* (MO). **CANADA, Nova Scotia**. Yarmouth Co.: 23 Jul 1921, *Fernald, Long & Bartram 23201* (MO). **Indiana**. Porter Co.: 27 Jun 1935, *Tyron Jr. 3718½* (MO). Jasper Co.: 12 Jul 1947, *Friesner 21662* (MO).



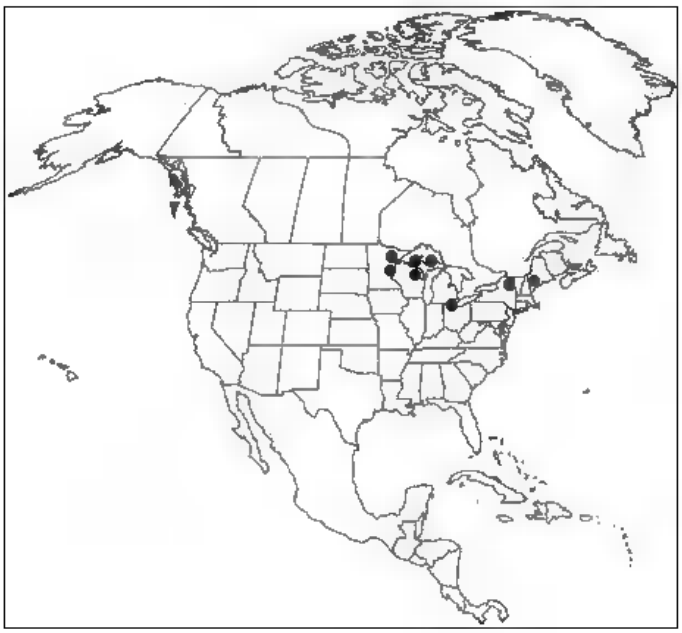
Once the cornerstone of Hitchcock and Chase's (1910, 1951) informal group "*Spreta*", *Dichanthelium spretum* seems a bit out of place within sect. *Lanuginosa*. It differs from all other members of the section in having more acute spikelets, longer sheaths and internodes, and strongly ascending panicle branches (narrow inflorescences). The most morphologically similar species is *D. longiligulatum*, which is smaller in stature, has smaller spikelets, and typically has a wider, more spreading inflorescence. Occasional specimens of *D. spretum* possess glabrous spikelets but this character does not appear to warrant taxonomic recognition. Along calcareous lake shores of the Great Lakes region, *D. lindheimeri* can loosely resemble *D. spretum* (see notes under *D. lindheimeri* for details).

13. DICHANTHELIUM SUBVILLOSUM (Ashe) Mohlenbr., Ill. Fl. Illinois (ed. 2), Grasses: *Panicum* to *Danthonia*, 383. 2001. *Panicum subvillosum* Ashe, J. Elisha Mitchell Sci. Soc. 16: 86. 1900. **TYPE: USA. Minnesota**. Carlton Co.: Label from photo of missing holotype (see LeBlond 2015): "Plants of the Southern United States ["Southern" crossed out]. ["Eastern North Carolina" crossed out]," August 1899, *Ashe s.n.* (US 971092, lectotype designated by LeBlond 2015; isolectotypes: NCU 18025, US 971092).

Panicum unciphyllum forma *pilosum* Scribn. & Merr., Rhodora 3: 124. 1901. **TYPE: USA. Maine**. Penobscot Co.: 7 Jul 1891, *Fernald 501* (holotype: US!).

Plants erect or ascending from a geniculate base, 10–50 cm tall; lowermost **internodes** pilose to villose and often double invested with short puberulent to pilose hairs (Figure 8b); the middle and upper **internodes** pilose to villose (Figure 8a); lowermost **sheaths** copiously pilose to villose and usually double invested with short puberulent to pilose hairs (Figure 8b), upper sheaths pilose to villose and lacking puberulent hairs (Figure 8a), longer hairs 1.0–2.0 mm long; **ligule** 0.7–1.5 mm long (Figs. 7b or d); **pseudoligule** 1.5–4.0 mm long, distinct or intermeshed with ligule; **leaf blades** spreading to ascending, 2–7 cm long, 3–7 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface villose to pilose, hairs uniformly distributed, abaxial surface pubescent to pilose; **panicles** 2–6 cm long, half as wide to as wide as long, pilose; **spikelets** 1.6–2.0 mm long,

approximately 1.0 mm wide, elliptic, pilose; **first glume** 0.7–1.0 mm long, typically 1/3 to 1/2 as long as the spikelet, obtuse to broadly acute.



Distribution and habitat. *Dichanthelium subvillosum* is sparsely distributed from Nova Scotia to Saskatchewan in the north, south to New York and Iowa. Its habitat consists of sandy prairies and open woods.

Representative specimens. **USA. Ohio**. Lucas Co.: 17 Jun 1940, *Kriebel 8731* (MO). **Maine**. Oxford Co.: 14 Jun 1931, *Hunnewell 11973* (MO). **Michigan**. Keweenaw Co.: 14 Jul 1956, *Bennett s.n.* (MO). **Minnesota**. Anoka Co.: 30 Jun 1888, *Schuette s.n.* (MO). Carlton Co.: 6 Aug 1899, *Ashe s.n.* (NCU). **New York**. Franklin Co.: 22 Jun 1930, *Muenscher & Maguire 933* (MO). **Wisconsin**. Ashland Co.: 1 Jul 1976, *Coffin 41* (MO). Oneida Co.: 29 Aug 1918, *Coffmann s.n.* (MO).

Though they provided no explanation, Gould and Clark (1978) placed *Dichanthelium subvillosum* in synonymy with *D. acuminatum* var. *acuminatum*. One must assume this placement is based on the superficial similarity of *D. subvillosum* to *P. lanuginosum* var. *fasciculatum* (*D. lanuginosum* in the present treatment), which was also placed in *D. acuminatum*, rather than any direct similarity to actual *D. acuminatum*. Freckmann and Lelong (2002, 2003) took a more conservative approach and elevated var. *fasciculatum* to subsp. *fasciculatum* under *D. acuminatum* and placed *D. subvillosum* as a synonym of this new combination. The present study demonstrates that *D. subvillosum* possesses several morphological characters that warrant specific recognition for this taxon. It differs from *D. lanuginosum* in having shorter true ligule (0.7–1.5 versus 2.0–5.0 mm long), the presence of a distinct pseudoligule, longer first glume (0.7–1.0 mm versus 0.3–0.8 mm long), and less autumnal branching, which is more limited to the base and lower sheaths in *D. subvillosum*. Furthermore, *D. subvillosum* differs strikingly from *D. acuminatum* in that *D. subvillosum* lacks ciliate leaf margins, is more sparsely pubescent, and has longer first glumes in relation to overall spikelet length (first glumes typically 1/3 to 1/2 the spikelet length in *D. subvillosum* versus first glumes typically 1/4 to 1/3 the spikelet length in *D. acuminatum*). The ranges of *D. subvillosum* and *D. acuminatum* are also distinct with *D. subvillosum* occurring in northern North America and *D. acuminatum* occurring in extreme southern North America and southward.

14. DICHANTHELIUM THERMALE (Bol.) Thomas, **comb. nov.** Basionym: *Panicum thermale* Bol., Proc. Calif. Acad. Sci. 2: 181. 1862. *Dichanthelium lanuginosum* var. *thermale* (Bol.) Spellenb., Madrono 23:151. 1975. *Dichanthelium acuminatum* var. *thermale* (Bol.) Freckmann, Phytologia 48: 107. 1981. *Dichanthelium acuminatum* subsp. *thermale* (Bol.) Freckmann & Lelong, Sida 20: 168. 2002. **TYPE: USA. California**. Sonoma Co.: unknown locality, [on hot rocks and in hot water flowing from Geyser springs and Geyser mountains, in the northern part of Sonoma County], no date, *Bolander 3941* (holotype: GH!; isotypes: MO, US).

Plants erect or ascending from a geniculate base, 6.5–42 cm tall; **internodes** of the lower stem double invested with short, often sparse, pilose hairs below a villose pubescence or conspicuously to sparsely pilose (Figs. 7a or b), mid-stem and upper-stem internodes singly invested with velutinose to villose pubescence (Figure 8a); **sheaths** conspicuously velutinose to villose, hairs 0.4–3.5 mm long (Figure 8a), the lower stem sheaths singly or double invested with short, pilose hairs (Figure 8b); **ligule** 0.6–3.5 mm long (Figs. 7a, b or d); **pseudoligule** distinct, lacking or intermeshed with ligule, 2–4 mm long; **leaf blades** spreading to ascending, 2–12 cm long, 4–12 mm wide, margins typically ciliate for no more than ¼ the blade length, adaxial leaf surface pilose to densely villose or velutinose, abaxial surface velutinose; **panicles** 4–9 cm long, half as wide to as wide as long, densely to sparely pilose to velutinose; **spikelets** 1.4–2.0 mm long, approximately 0.5–1.0 mm wide, elliptic, pilose; **first glume** 0.4–1.0 mm long, typically equal or less than 1/3 the length of the spikelet, acute to broadly acute.

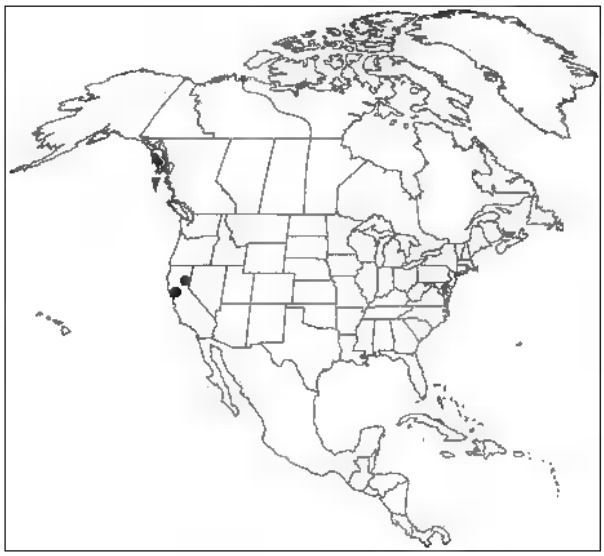
14a. Dichanthelium thermale subsp. **thermale**

Panicum lasseniamum Schmoll, Madrono 5: 95–96. 1936. **TYPE: USA. California**. Plumas Co.: Hot Spring Valley, Devil's Kitchen, 6200 ft., 6 Jun 1910, *W.L. Jepson 4082* (holotype: US!; isotype: UC).

Plants erect or ascending from a geniculate base, 12–42 cm tall; **internodes** of the lower stem double invested with short, often sparse, pilose hairs below a villose pubescence (Figure 8b), mid-stem and upper-stem internodes single invested with velutinous to villose pubescence (Figure 8a); **sheaths** conspicuously velutinous to villose, hairs 0.4–2.4 mm long (Figure 8a), the lower stem sheaths double invested with short, pilose hairs (Figure 8b); **ligule** 0.6–1.5 mm long (Figs. 7b or d); **pseudoligule** usually distinct, 2–4 mm long; **leaf blades** spreading to ascending, 2–12 cm long, 4–8 mm wide, margins typically ciliate for no more than ¼ the blade length, adaxial leaf surface densely villose to velutinose, abaxial surface velutinose; **panicles** 4–9 cm long, half as wide to as wide as long, pilose to velutinose; **spikelets** 1.4–2.0 mm long, approximately 0.5–1.0 mm wide, elliptic, pilose; **first glume** 0.5–1.0 mm long, typically equal or less than 1/3 the length of the spikelet, acute to broadly acute.

Distribution and habitat. *Dichanthelium thermale* subsp. *thermale* is only found in the warm, mineral rich soils of isolated hot springs in the Cascade Mountains of northern California.

Representative specimens. **USA. California**: Plumas Co.: 6 Jun 1910, *Jepson 4082* (US). Shasta Co.: Jun 1899, *Greata s.n.* (US). Sonoma Co.: 1865, *Bolander 3991* (MO). Sonoma Co.: 1866, *Bolander 3941* (GH). Sonoma Co.: 27 Aug 1872, *Redfield 9792* (MO). Sonoma Co.: 5 Jul 1931, *Jones 29210* (MO).



Gould and Clark (1978) placed *Dichanthelium thermale* in synonymy with *D. acuminatum*, while Freckmann and Lelong (2003) treated *D. thermale* as a subspecies of *D. acuminatum* (subsp. *thermale*). Given the disjunct range, specialized habitat and morphological autonomy of *D. thermale*, these treatments prove unsatisfying. Morphologically, *D. thermale* differs from *D. acuminatum* in having limited marginal cilia on the vernal leaf blades and by possessing a double vestiture on the culms and sheaths of the vernal stem that *D. acuminatum* lacks. There is significant morphological variation in leaf size, pubescence density, and spikelet length throughout the range of *D. thermale* (Hitchcock & Chase 1910). This could be attributed to inbreeding or genetic drift associated with their isolated populations and the island-like nature of their habitats. Schmoll (1939) attempted to sort out the variation in the *D. thermale* complex. In so doing, she limited *D. thermale* to the hot springs in Sonoma Co., California, described a new species (*P. lassenianum*) for plants occurring in Plumas County (California), described a new species (*P. ferventicola*) from Yellowstone National Park (Wyoming), and described two new varieties of *P. ferventicola* (vars. *papillosum* and *sericeum*), one in the vicinity of Banff, Alberta, and another in Yellowstone National Park. Relative to the differences found in other taxa in the section, the present work could find no meaningful difference between what she called *P. thermale* and *P. lassenianum*, nor was any appreciable difference noted between what she called *P. ferventicola* and *P. ferventicola* var. *papillosum* and var. *sericeum*. Thus, *P. lassenianum* of Schmoll (1939) is here relegated to *D. thermale*. *Panicum ferventicola* and varieties are here treated as *D. thermale* subsp. *sericeum*. However, due to the scarcity of collections and the authors admitted unfamiliarity with the region, the present treatment is not entirely satisfying. The type specimen of *P. ferventicola* seems rather intermediate between the *D. thermale* of California and subsp. *sericeum* of the Rocky Mountains. It is because of this similarity in morphology and habitat that subsp. *sericeum* is linked to *D. thermale* instead of *D. acuminatum* as other authors have contended (Gould & Clark 1978; Freckmann & Lelong 2003). It is tempting to follow the treatment of Hitchcock and Chase (1951), which lumped those taxa described by Schmoll (1939) into *D. thermale* (then as *P. thermale*), but this would be significantly less satisfying given the obvious differences in *D. thermale* and *D. thermale* subsp. *sericeum*. Essentially, the present work serves to provide a basic taxonomic framework that well represents the larger trends in morphological variation for the *D. thermale* complex. In order to more fully elucidate the ultimate taxonomy of these scattered and isolated groups, detailed field studies will be necessary. I suspect the results of such research will more closely resemble the treatment put forth by Schmoll than any work done up to and including the present.

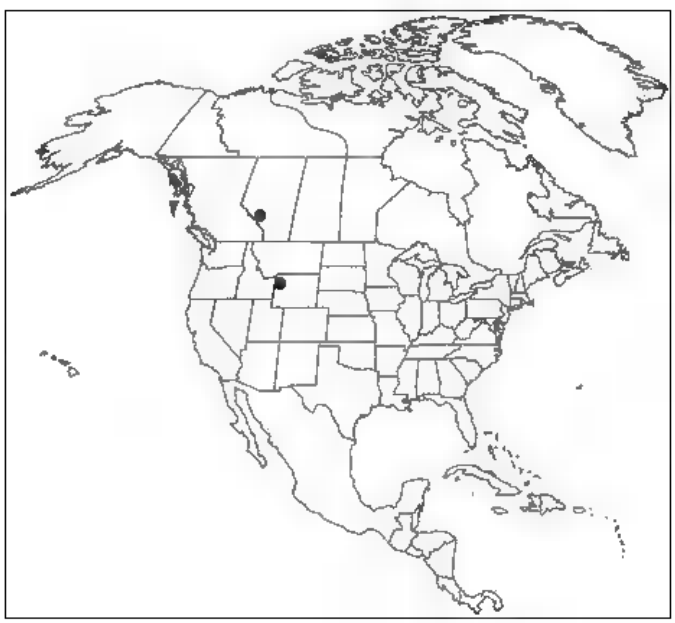
Redman et al. (2002) have demonstrated that *Dichanthelium thermale* possesses a fungal endophyte of the genus *Curvularia*. This endophyte equips *D. thermale* with the heat tolerant proteins and enzymes that allow it to survive soil temperatures in excess of 60°C (Redman et al., 2002). Further research by Marquez et al. (2006) demonstrated even more complexity in the relationship in describing that ▪ virus within the fungus is responsible for the protein stability inferred, secondarily, by the fungal endophyte; resulting in ▪ three-way mutualism. *Dichanthelium thermale* closely resembles *D. subvillosum*, a species of northern North America.

14b. Dichanthelium thermale subsp. **sericeum** (Schmoll) Thomas, **comb. nov.** Basionym: *Panicum ferventicola* var. *sericeum* Schmoll, Madrono 5: 93–94.1939. *Dichanthelium lanuginosum* var. *sericeum* (Schmoll) Spellenb., Madrono 23: 150. 1975. *Dichanthelium acuminatum* subsp. *sericeum* (Schmoll) Freckmann & Lelong, Sida 20: 168. 2002. **TYPE: USA. Wyoming**. Yellowstone National Park, Mammoth Hot Springs, in wet ground about hot springs, 21 Jul 1889, *Nelson & Nelson 6037* (holotype: RM!; isotypes: NY, US!).

Panicum ferventicola Schmoll, Madrono 5: 92–95: 1939. **TYPE: USA. Wyoming**. Park Co.: Yellowstone National Park, 5 mi N of Norris Geyser Basin, 10 Aug 1908, *Chase 5252* (holotype: GH!; isotypes: F!, NY, US!).

Panicum ferventicola var. *papillosum* Schmoll, Madrono 5: 94. 1939. **TYPE: CANADA. Alberta**. Banff, on ▪ declivity wet with water from hot spring, 31 Jul 1914, *Hitchcock 11511* (holotype: GH!; isotypes: F!, NY, US!).

Plants erect to ascending from ▪ geniculate base or forming prostrate mats, 6.5–32 cm tall; **internodes** conspicuously to sparsely pilose (Figure 8a); **sheaths** copiously pilose to velvety villose (Figure 8a), hairs 2.0–3.5 mm long; **ligule** 2.0–3.5 mm long (Figs. 7a or d); **pseudoligule** lacking or intermeshed with ligule; **leaf blades** spreading to ascending, 3–6 cm long, 5–12 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface pilose to villous with the longest hairs typically 1.5–4.0 ▪▪▪ long, abaxial surface short pilose with the longest hairs typically 0.5–1.5 mm long; **panicles** 3–6 cm long, as wide as long, densely to sparsely pilose; **spikelets** 1.6–1.8 mm long, 0.7–1.0 mm wide, elliptic, pilose; **first glume** 0.4–0.7 mm long, typically 1/4 to 1/5 the length of the spikelet, acute to broadly acute.



Distribution and habitat. *Dichanthelium thermale* subsp. *sericeum* is restricted to the margins of hot springs and geysers in the Rocky Mountains. Verified populations occur in the vicinity of Banff, Alberta, and Yellowstone National Park, Wyoming.

Representative specimens. **CANADA, Alberta**. Banff, 31 Jul 1914, *Hitchcock 220* (GH). **USA. Wyoming**. Teton Co.: 21 Jul 1899, *Nelson & Nelson 6037* (GH). Teton Co.: 10 Aug 1908, *Chase 137* (GH).

A general lack of specimens and a high degree of morphological variation due to isolated populations makes this a difficult taxon to define. However, variations in morphology from the typical subspecies warrant some level of taxonomic recognition (see notes under *D. thermale*). *Dichanthelium thermale* subsp. *sericeum* differs from the typical subspecies in having a long pilose pubescence, a single ligule, and unusually short and wide leaves. Further study involving population level analyses from multiple locations within the range of *D. thermale* will be necessary to fully understand the morphological expression of the *D. thermale* complex.

15. DICHANTHELIUM VILLOSISSIMUM (Nash) Freckmann, Phytologia 39: 270. 1978. *Panicum villosissimum* Nash, Bull. Torrey Bot. Club 23:149. 1896. *Dichanthelium lanuginosum* var. *villosissimum* (Nash) Gould, Brittonia 26: 60. 1974. *Dichanthelium ovale* subsp. *villosissimum* (Nash) Freckmann & Lelong, SIDA 20: 170. 2002. **TYPE: USA. Georgia**. Bibb Co.: in the Ocmulgee River swamp, below Macon, 18–24 May 1895, *Small s.n.* (holotype: NY!; isotypes: NY!, US).

Panicum nitidum var. *villosum* A. Gray, N. Amer. Gram. 2: 111. 1835. *Panicum dichotomum* var. *villosum* (A. Gray) Vasey, Dept. Agric. Bot. Div. Bull. 8: 31. 1889. *Dichanthelium acuminatum* var. *villosum* (A. Gray) Gould & Clark, Ann. Missouri Bot. Gard. 65: 1124. 1978. *Panicum acuminatum* var. *villosum* (A. Gray) Beetle, Phytologia 48: 192. 1981. *Panicum ovale* var. *villosum* (A. Gray) Lelong, Brittonia 36: 272. 1984. **TYPE: USA. District of Columbia**. Rock Creek, near Pierce's Mill, 1 Jul 1883, *Vasey s.n.* (lectotype: US!, designated by Hitchcock & Chase, Contr. U.S. Natl. Herb. 15: 233. 1910).

Panicum pseudopubescens Nash, Bull. Torrey Bot. Club 26: 577. 1899. *Panicum villosissimum* var.*pseudopubescens* (Nash) Fernald, Rhodora 36: 79. 1934. *Panicum ovale* var. *pseudopubescens* (Nash) Lelong, Brittonia 36: 271. 1984. *Dichanthelium villosissimum* var. *pseudopubescens* (Nash) Mohlenbr., Erigenia 6: 26. 1985. *Dichanthelium ovale* subsp. *pseudopubescens* (Nash) Freckmann & Lelong, Sida 20: 170. 2002. **TYPE: USA. Alabama**. Lee Co.: collected at Auburn, 7 May 1898, *Earle & Baker 1537* (holotype: NY!; isotype: US!).

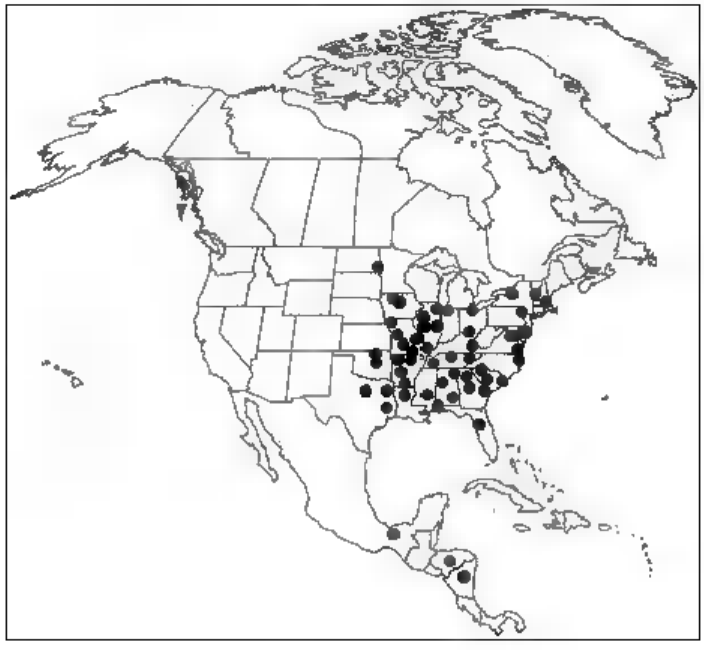
Panicum atlanticum Nash, Bull. Torrey Bot. Club 24: 346–347. 1897. **TYPE: USA. New York**. Kings Co.: on dry somewhat shaded knolls in the grounds of the New York Botanical Garden, 24 Jun 1897, *Nash s.n.* (holotype: NY!; isotype: US!).

Panicum haemacarpon Ashe, J. Elisha Mitchell Sci. Soc. 15: 55. 1898. **TYPE: USA. District of Columbia**. in the vicinity of Washington D.C., 6 Jun 1897, *Kearney s.n.* (lectotype: NY!, designated by Hitchcock and Chase, Contr. U.S. Natl. Herb. 15: 233. 1910; isolectotypes: US!, NCU!).

Panicum xanthospermum Scribn. & Mohr, Contr. U.S. Natl. Herb. 6: 348. 1901. **TYPE: USA. Alabama**. Butler Co.: Greenville, collected in open sandy soil, 8 May 1898, *Mohr s.n.* (holotype: US!; isotype: NY).

Plants erect or ascending from a geniculate base, 10–60 cm tall; **internodes** conspicuously to sparsely villose to long pilose (Figure 8a), hairs ascending to appressed; **sheaths** copiously villose to long pilose, rarely double invested with short pilose pubescence below a long villose pubescence (Figs. 7a or b), erect to ascending and 1.4–3.8 mm long; **ligule** 0.3–1.3 mm long (Figure 8b);

pseudoligule distinct, 2.0–5.0 mm long; **leaf blades** spreading to ascending, 3–11 cm long, 3–12 mm wide, margins ciliate only at the base of blade or eciliate, adaxial leaf surface copiously villose to sparsely pilose with uniformly distributed hairs, abaxial surface pilose; **panicles** 4–10 cm long, half as wide to as wide as long, densely to sparsely pilose to villose; **spikelets** 1.8–2.5 mm long, approximately 0.9–1.2 mm wide, elliptic, pilose; **first glume** (0.6–) 0.8–1.0 (–1.3) mm long, typically 1/4 to 1/3 the length of the spikelet, acute to broadly acute.



Distribution and habitat. *Dichanthelium villosissimum* is found throughout eastern North America from Massachusetts, southern Ontario and Minnesota, south to Texas, Mexico, and into Central America. It is typically found in acidic soils of sand or chert substrate. Throughout its range it is associated with dry pine or oak-hickory forests and woodlands.

Representative specimens. **GUATAMALA**. 13 Sep 1896, *Seler 3235* (MO). **HONDURAS**. **Intibuca**. 21 Jun 1994, *Davidse 35207* (MO). **MEXICO**. **Chiapas**. 5 Nov 1981, *Breedlove 54707* (MO). **USA**. **Alabama**. Butler Co.: 8 May 1898, *Mohr s.n.* (US). Dekalb Co.: 27 May 1974, *Kral 53030b* (MO). Lee Co.: 7 May 1898, *Earl & Baker 1537* (NY). Pickens Co.: 21 May 1960, *McDaniel 1839* (MO). **Arkansas**. Garland Co.: 18 Aug 1937, *Demaree 15843* (MO). **District of Columbia**. 6 Jun 1897, *Kearney Jr. s.n.* (US). 12 Jun 1894, *Holmgren s.n.* (MO). **Georgia**. Bibb Co.: 18–24 May 1895, *Small s.n.* (NY). Dade Co.: 8 May 1948, *Cronquist 5164* (MO). Murray Co.: 18 Jul 1973, *Kral 50687* (MO). Screven Co.: 17 Apr 1948, *Cronquist 5006* (MO). **Illinois**. Cook Co.: 21 Jun 1891, *Moffatt s.n.* (MO). Henderson Co.: *Patterson s.n.* (MO). **Iowa**. *Jones 34* (MO). **Mississippi**. 1858, *Higland s.n.* (MO). **Missouri**. Benton Co.: 24 May 1936, *Steyermark 10744* (MO). Carter Co.: 7 Jun 2001, *Thomas 1399* (private). Ozark Co.: 1 Jul 1937, *Steyermark 22589* (MO). Barry Co.: 6 Jun 1897, *Bush 141* (MO). **New Jersey**. Passaic Co.: 14 Jul 1907, *MacKenzie 2724* (MO). **New York**. Bronx Co.: 24 Jun 1897, *Nash s.n.* (NY). Seneca Co.: 24 Jun 1914, *Randolf 11249* (MO). **North Dakota**. Richland Co.: 27 Jun 1940, *Stevens 459* (MO). **South Carolina**. Bamberg Co.: 17 May 1966, *Freckmann 2133* (MO). Williamsburg Co.: 10 Jul 1939, *Godfrey 428* (MO). **Tennessee**. Hardeman Co.: 14 May 1920, *Palmer 19493* (MO). Knox Co.: Jun 1896, *Ruth s.n.* (MO). Knox Co.: Aug 1894,

Ruth s.n. (MO). **Texas**. Gregg Co.: 18 Jun 1907, *Reverchon s.n.* (MO). Polk Co.: 10 May 1973, *Gould & Hatch 14223* (MO). **Virginia**. Alexandria Co.: 9 Jun 1905, *Chase 555* (MO). Princess Ann Co.: 3 Sep 1905, *MacKenzie 1710* (MO). Norfolk Co.: 11 Jun 1940, *Fernald & Long 11969* (MO).

The most striking features of *Dichanthelium villosissimum* are the density and length of its pubescence. This is especially noticeable on the sheaths and culms of the vernal stem where hairs are often in excess of 3.0 mm long. Past treatments (Ashe 1898; Braun 1967; Deam 1940; Fernald 1950; Gleason & Cronquist 1991; Hitchcock & Chase 1910; Hitchcock & Chase 1951; Jones 1945; Mohlenbrock 1986; Pohl 1947; Radford et al. 1968; Small 1933; Steyermark 1963; Stone 1911; Swink & Wilhelm 1994) involving sect. *Lanuginosa* have maintained *D. villosissimum* as a distinct species, subspecies, or variety. Gould and Clark (1978) treated it as a variety of *D. acuminatum* (*D. acuminatum* var. *villosum*). Beetle (1981) and Zuloaga (1993b) treated it as a variety of *P. acuminatum* (*P. acuminatum* var. *villosum*). However, the present work demonstrates ample morphological resolution to warrant distinction at the rank of species. *Dichanthelium villosissimum* differs from *D. acuminatum* in having significantly larger spikelets, longer sheath pubescence, and a lack of extensive marginal cilia along the blades of the vernal leaves. Freckmann and Lelong (2002, 2003) placed *D. villosissimum* as a subspecies of *D. ovale*. For a discussion of the differences between *D. ovale* and *D. villosissimum* see the notes under *D. ovale* and *D. praecocius*.

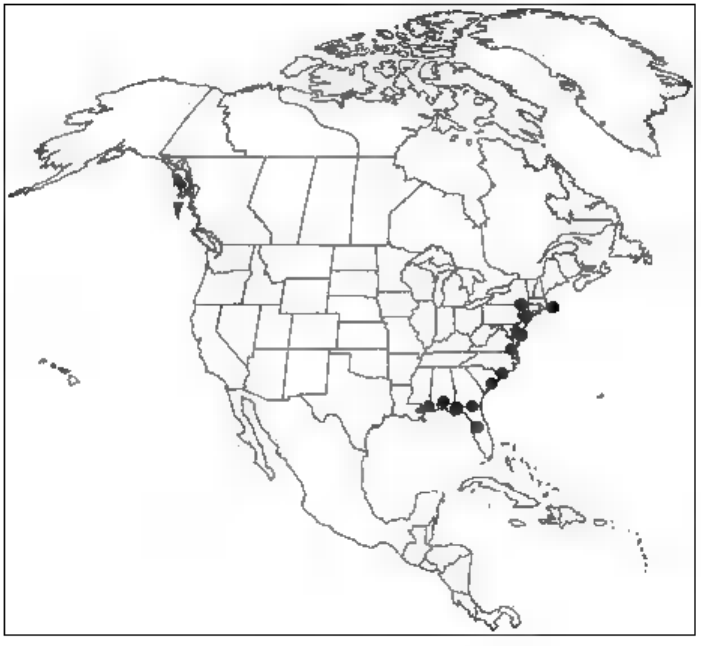
Freckmann and Lelong (2002, 2003) also placed *Panicum pseudopubescens* as a subspecies of *Dichanthelium ovale* and differentiated it from subsp. *villosissimum* (*D. villosissimum* in the present treatment) as having shorter sheath pubescence that is ascending or appressed instead of spreading or retrorse. They further stated that subsp. *pseudopubescens* intergrades morphologically with subsp. *villosissimum*. Though the type specimen of *P. pseudopubescens* does have shorter sheath pubescence than typical *D. villosissimum*, the present study could find no meaningful morphological separation between the two. Nor was any correlation between sheath pubescence length and orientation found. Thus *P. pseudopubescens* is here placed in synonymy with *D. villosissimum*. However, subsequent field experience with this taxon and herbarium investigations, including a re-evaluation of material used in the analysis, suggest that it was likely underrepresented in the database and likely constitutes a definable species. Deam's (1929) and Swink and Wilhelm's (1994) treatments refer to the upper leaf surfaces of *P. pseudopubescens* as being pubescent only along the margins. However, the entity to which they are referring is *P. commonsianum*. This has led to numerous misidentification of Midwestern *D. commonsianum* as *P. pseudopubescens*. The leaf character to which Deam (1929) referred is limited to three taxa within the section (*D. columbianum*, *D. ovale*, and *D. commonsianum*). Morphologically, *D. villosissimum* is closely aligned with and easily confused with *D. praecocius*. For a discussion of the differences see notes under *D. praecocius*.

16. DICHANTHELIUM WRIGHTIANUM (Scribn.) Freckmann, Phytologia 48: 101. 1981. *Panicum wrightianum* Scribn., USDA. Div. Agrostol. Bull 11: 44. 1898. *Dichanthelium acuminatum* var. *wrightianum* (Scribn.) Gould & Clark., Ann. Missouri Bot. Gard. 65: 1126. 1978. *Panicum acuminatum* var. *wrightianum* (Scribn.) Reed, Phytologia 80: 284. 1996. **TYPE: CUBA**. unknown locality, 1865, *Wright 3463*, (lectotype: US!, designated by Hitchcock and Chase, Contr. U.S. Natl. Herb. 15: 210. 1910; isolectotypes: GH, MO!, NY, US).

Panicum deminutivum Peck, New York State Mus. Bull. 10: 27. 1907. **TYPE: USA. New York**. Suffolk Co.: Wading River, 20 Aug 1906, *Peck s.n.* (holotype: NY!; isotypes: NY!, US).

Plants erect or ascending from a geniculate base, 5–40 cm tall; **internodes** puberulent and often pilose (Figs. 7c or d); **sheaths** double invested with short puberulent hairs below a pilose or villous pubescence (Figure 8d), the upper merely puberulent (Figure 8c), longer hairs 0.1–0.8 mm long; **ligule** 1.7–3.1 mm long (Figure 8a); **pseudoligule** absent or indistinguishable from ligule; **leaf blades** spreading to ascending, 1.5–4.5 cm long, 2.0–4.5 mm wide, margins ciliate only at the base of

blade or ciliate, adaxial leaf surface puberulent, pilose or both, abaxial surface puberulent; **panicles** 1.5–6.0 cm long, half as wide to as wide as long, puberulent; **spikelets** 0.8–1.0 mm long, approximately 0.4–0.6 mm wide, elliptic, puberulent; **first glume** 0.2–0.4 mm long, typically 1/3 as long as the spikelet, obtuse to acute.



Distribution and habitat. *Dichanthelium wrightianum* ranges along the coastal plain of North America from Massachusetts to Florida and Texas and south through Central America and northern South America. It is also found in the Caribbean Islands. Its habitat consists of saturated to seasonally saturated bogs, savannas, and open woods with sandy, peaty, or mucky soils.

Representative specimens. **CUBA**. 1860-1864, *Wright 3463* (MO). **USA**. **Georgia**. Lowndes Co.: 10 Jul 1968, *Faircloth 5282* (MO). **Florida**. Suwannee Co.: 7 Jun 1900, *Curtiss 6652* (MO). **Massachusetts**. Barnstable Co.: 24 Jun 1909, *Knowlton s.n.* (MO). **Mississippi**. Jackson Co.: 6 May 1898, *Tracy 4885* (MO). **New York**. Delaware Co.: 20 Aug 1906, *Peck s.n.* (US). **North Carolina**. *Bosc s.n.* (US). **Virginia**. Sussex Co.: 6 Jul 1942, *Fernald & Long 14267* (MO).

Given its tiny spikelets and diminutive stature, there is little debate that *Dichanthelium wrightianum* is a distinct species. Morphologically, it is closely aligned with *D. leucothrix*, *D. meridionale*, and *D. longiligulatum*. These four taxa are smaller than others in the section, have relatively small spikelets, and possess varying degrees of puberulence often under a longer pilosity. The extremely small spikelets of *D. wrightianum* easily distinguish it from other members of the section. Gould and Clark (1978) placed *D. wrightianum* as a variety of *D. acuminatum* yet provided no direct evidence for this lumping. Every treatment before and since Gould and Clark (1978) has maintained *D. wrightianum* as a distinct species.

ACKNOWLEDGEMENTS

I would like to thank Doug Ladd, Scott Namestnik, and Dana Thomas for their reviews of the manuscript from its early drafts onward and for their encouragement. I am also grateful for the encouragement and feedback I received from George Yatskievych, Michael Vincent, W. Hardy Eshbaugh, Jim Hickey, and Robert Naczi. Scott Namestnik, Doug Ladd, and Jacob Hadle were especially helpful in providing feedback from their use of the keys in a field context as well as from their personal experiences with sect. *Lanuginosa* in their respective regions. Thanks also to the herbaria of F, GH, MIN, MO, MU, NCU, NY, URV, US, WIS, and WS, from which specimens were graciously loaned.

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EURYTAENIA TEXANA (APIACEAE) NATIVE TO LOUISIANA

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Eurytaeni texana Torr. & Gray is relatively widespread, though not abundant, through central Texas to north-central Oklahoma, not quite reaching Kansas. It occurs mostly in sandy habitats from abandoned fields, pastures, roadsides, sandy prairies, mesquite savannas, and floodplains to oak-juniper and live oak-post oak woodlands (Nesom 2012). The present note documents the native occurrence of the species in a prairie remnant in northwestern Louisiana (Fig. 1).

Louisiana. Caddo Par.: Shreveport, North Lakeshore Drive at Roy Road, prairie remnmant, margin of elm-oak forest, hard clay, common biennial-perennial, 21 Apr 1998, *S.R. Hill 30040* (MO); ca. 4 mi SE of Blanchard, S of La Hwy 173, roadbanks of North Lakeshore Drive, 29 May 1979, *Thomas 65016* (MO-2 sheets). The two localities are described differently but both collections appear to be from the very same place, on the west-northwest perimeter of Shreveport, about 2.3 miles from Interstate Hwy 20, slightly north of Cross Lake, southeast of Lakeview Park.

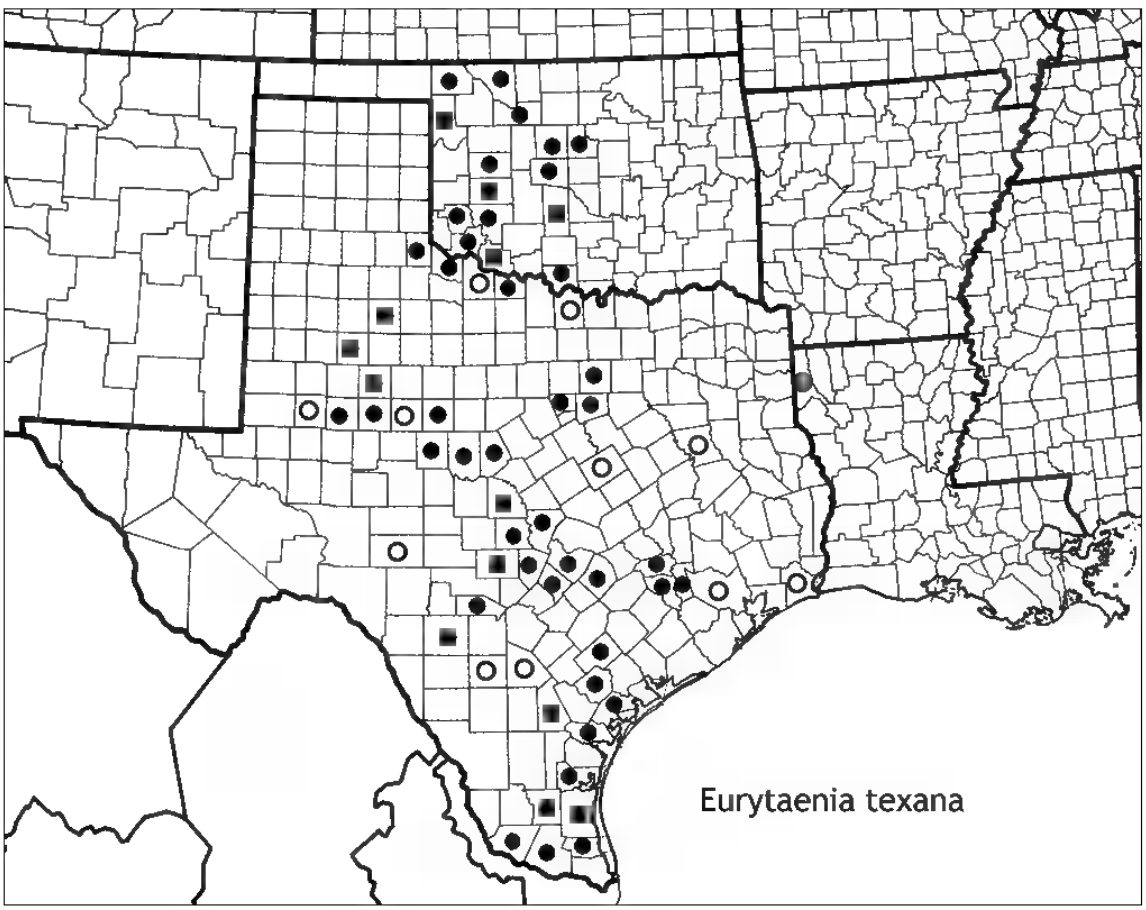

Figure 1. Distribution of *Eurytaenia texana*. Solid dots from Nesom (2012), open symbols from Hannick et al. (2013) and Turner et al. (2003); blue-filled symbol represents new record from Caddo Parish, Louisiana.

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DISCOVERY OF *AJUGA CHAMAEPITYS* (LAMIACEAE) NATURALIZED IN TEXAS

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ABSTRACT

Ajuga chamaepitys is reported as naturalized in a horse pasture along the eastern banks of White Oak Creek in Gillespie County of the Edwards Plateau. This is the second naturalized species of *Ajuga* known in Texas. The restricted distribution of this species suggests that it was established by adulterated forage transported with horse stock.

Ongoing floristic inventory in the Edwards Plateau of south-central Texas has resulted in the discovery of naturalized populations of *Ajuga chamaepitys* (L.) Schreb. This is the third state of the USA where this species has been documented (Virgina, Maryland, and Texas).

Voucher specimens: **TEXAS**. Gillespie Co.: Terra Linda Estates, ca. 15 km at 356 degrees from Kerrville (Kerr Co.), lat. 30°10'43.58", long. 99°08'55.62", ca. 595 m elev., 6 Apr 2015, *W.C. Holmes, J.R. Singhurst & J.N. Mink 16134* (BAYLU); same general location, lat. 30°11'01.22", long. 99°08'41.63", same collectors and date, *16135* (BAYLU); same general location, lat. 30°11'18.68", long. 99°08'11.30", same collectors and date, *16130* (BAYLU). Figure 1.

The Gillespie County pasture, which is about 1.9 km long and varies from about 50 to 230 m in width, was densely and evenly covered with *Ajuga*. Associated vegetation within the pasture included *Nassella leucotricha*, *Salvia farinacea*, *Marrubium vulgare*, *Glandularia bipinnatifida*, *Verbena halei*, *Ratibida columnifera*, *Lesquerella recurvata*, *Scutellaria drummondii*, *Arenaria* sp., *Evax* sp., and *Chaerophyllum tainturieri*. Peripheral herbaceous vegetation and woody shrubs and trees included *Desmodium paniculatum*, *Desmodium psilophyllum*, *Ulmus crassifolia*, *Juniperus ashei*, *Quercus buckleyi*, *Celtis laevigata*, with *Taxodium distichum* and *Platanus occidentalis* along the littoral zone of White Oak Creek.

The genus *Ajuga* comprises 40-50 species of decumbent and erect annuals and perennials in North Africa, Mediterranean Europe, Great Britain, Israel, Asia, and Australia, distributed mostly in cooler regions (Cheifetz et al. 1999). *Ajuga chamaepitys* is native to central and southern Europe, the eastern Mediterranean region, and North Africa. None of the species are native to the Western Hemisphere (Diggs et al. 1999).

Until now, only *Ajuga reptans* L. was known from Texas (Cory & Parks 1937; Gould 1962; Correll & Johnston 1970; Hatch et al 1990; Johnston 1990; Jones et al. 1997; Turner et al. 2003; Hannick et al 2013). *Ajuga chamaepitys* was first reported in the USA in 1981 from Virginia (Harvill et al. 1981) and later from Maryland (Brown & Brown 1984). Three other species of *Ajuga* are known adventives or have escaped cultivation in North America (Radford et al. 1965; Strausbaugh & Core 1977; Kartesz 2015): *(1) A. genevensis*, in the northeastern USA and southeastern Canada (Gleason & Cronquist 1991; Brouillet et al. 2006; Kartesz 2015), (2) *A. reptans*, widespread throughout the USA except the Dakotas, Minnesota, Nebraska, Wyoming, Colorado, New Mexico, Nevada, California and Arizona (Gleason & Cronquist 1991; Brouillet et al. 2006; Kartesz 2015), and (3) *A. pyramidalis*, known only from Washington County, Mississippi (Bryson & Skojac 2011). The following key, adapted from Stace (1997), distinguishes the three species in the southern USA.

KEY TO *AJUGA* NATURALIZED IN SOUTHERN USA

1. Annuals; leaves dissected; plants neither stoloniferous nor rhizomatous; corollas yellow ..... **Ajuga chamaepitys**
1. Perennials; leaves subentire or serrate; plants stoloniferous or rhizomatous; corollas blue, pink or white.

2. Plants rhizomatous; all bracts longer than flowers; stem puberulence continuous around stems ..... **Ajuga pyramidalis**
2. Plants stoloniferous; upper bracts shorter than flowers; upper part of stem puberulence discontinuous around stems (only on 2 opposite sides) ..... **Ajuga reptans**

Ajuga chamaepitys in the Texas flora may remain localized, given its disjunct pattern of distribution in the USA (Virginia-Maryland and Texas), coupled with its known edaphic requirements of limestone, calcareous substrates, and calciferous soils (Lousley 1950; Stace 1997). Although Turrill (1948) described a large-scale ecological cline in the geographic distribution of the species from Asia Minor across Europe, this plant is designated by others as uncommon, decreasing or restricted in England (Lousley 1950; Stace 1997). Jim Scuddy, land manager of Terra Linda Estates, observes that the plant has been present in the Gillespie County horse pasture since the 1980s; no dispersal of *A. chamaepitys* has been observed outside of this area.

The establishment of *Ajuga chamaepitys* in the USA probably is connected to horseracing and horse recreational pursuits and the importation of horse stock from Europe and the Middle East (Weatherby 1791; Shouse 1908; Prior 1935; Wentworth 1938; Lightcap 1940) — seeds may have arrived via ruminant gut remnants or adulterated forage. Livestock forage as a vector for plant propagules is well known (Dewey 1897; Hillman & Henry 1928; Clines 2005) and interstate regulations related to weed-free hay are lax.

ACKNOWLEDGEMENTS

We thank Jim Scuddy, Ranch Manager of Terra Linda Estates, who brought the first sample of the species to Jim and Priscilla Stanley, naturalists and residents of Terra Linda Estates. Photos were then passed on to the authors, which led to plans for visiting the site. We also thank Jeff Forman, Wildlife Biologist at Mason Mountain Wildlife Management Area (MMWMA), who suggested that the plant might be *Ajuga chamaepitys* and Bill Carr of the University of Texas Herbarium for confirming the identification.

Figure 1. *Ajuga chamaepitys*, ground-pine or yellow bugle, in Gillespie Co., Texas, 6 April 2015. Photo by Jason Singhurst.

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NOMENCLATURAL NOTES ON HORTICULTURAL HYBRIDS: *DAHLIA* 'MEXICAN BLACK,' *POTENTILLA* AND OTHER ROSACEAE, *STYLOPHORUM*, AND *TIGRIDIA*

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ABSTRACT

Nomenclatural notes are provided on plants of four families. (1) Plants of the putative hybrid *Cosmos* × *Dahlia* 'Mexican Black' have been examined and compared with *Cosmos* and *Dahlia*. All the features examined relate to *Dahlia* rather than *Cosmos* and it is concluded that 'Mexican Black' is a *Dahlia*. (2) Names are provided for 13 intergeneric hybrids in Rosaceae and a hybrid name is validated as **× Tormariosorbus intermedia** (Ehrh.) Mezhenskyj ex J.M.H.Shaw, **comb. nov**. (3) A spontaneous garden hybrid between the North American *Stylophorum diphyllum* and the Chinese *S. lasiocarpum* is described as **Stylophorum × crugianum** J.M.H. Shaw. (4) The artificial hybrid *Tigridia pavonia* × *T. orthantha* (formerly *Rigidella*) is described as **Tigridia × mathewii** J.M.H. Shaw.

***Dahlia* 'Mexican Black'** (Asteraceae)

For several years 'Mexican Black' has been listed and sold in the horticultural trade as a bigeneric hybrid of *Cosmos* × *Dahlia*. It is widely accepted as a bigeneric hybrid in horticultural literature (Cubey, 2015; Dillon, 2015), and due to the dark maroon colour of the florets, it is usually speculated that *Cosmos atrosanguineus* is one of the parents. To gain insights in to the identity of 'Mexican Black,' plants were grown alongside several *Cosmos* and *Dahlia* accessions and compared morphologically. Recent floristic treatments of Mexican Asteraceae (McVaugh 1984; Turner 2010) note that *Cosmos* and *Dahlia* are distinguishable by a suit of characters, of which the pubescent filaments in *Cosmos* is a synapomorphy for the genus in *Coreopsideae* (Crawford et al. 2009).

Comparison of 'Mexican Black' with *Dahlia coccinea* revealed many similarities, notably large swollen tubers, similar fleshy foliage, outer phyllaries large and fleshy, glabrous filaments, style arms with long papillae, flat achenes without a pappus, and the distinctive aroma of *Dahlia* tissues when dissected. On the other hand comparison with *Cosmos atrosanguineus* revealed several differences, notably the presence of hairs on the anther filaments in *Cosmos*, which has much thinner slightly fleshy roots, thin foliage, style arms with short papillae and a distinctive shape, and quadrangular, though immature achenes with a pappus of two retrorsely barbed bristles, features all well illustrated in Hind and Fay (2003). This comparison was quite convincing in itself that 'Mexican Black' was a *Dahlia*.

It is of interest that dark blackish maroon flowers in dahlias are not unique to 'Mexican Black.' At least a further 14 cultivars produce similarly coloured flowers and the molecular basis for this has been elucidated recently by Thill et al. (2012). Hence the dark flower colour is not of itself indicative of hybridisation with *Cosmos atrosanguineus*.

Molecular investigations based on both nuclear and plastid sequences have revealed that after *Hidalgoa*, *Dahlia* along with *Dicranocarpus parviflora* is sister to the remaining *Coreopsideae*, and *Cosmos*, which appears to be monophyletic, is some distance away in a clade containing parts of *Coreopsis* and *Coreocarpus*, both of which are polyphyletic as presently circumscribed (Crawford et al. 2009). Consequently, *Cosmos* and *Dahlia* are not particularly close. This is further borne out by Mii (2009) and collaborators, who attempted to breed new horticulturally valuable plants from *Cosmos atrosanguineus* and using plastic sequences determined it to be clearly a member of *Cosmos* rather than *Dahlia*, with *C. bipinnatus* and *C. sulphureus* as its nearest relatives (Oku et al. 2008). Mii

reported ovule swelling occurred only in hybrids of *C. atrosanguineus* with *C. sulphureus*, and triploid plantlets were obtained only after intervention with embryo rescue. The resultant hybrids have since been marketed as clonal cultivars in Japan. Colchicine induced amphidiploids were able to back-cross successfully with *C. sulphureus*, but not with *C. atrosanguineus*. Given the admitted difficulty of hybridizing *C. atrosanguineus* with other closely related congeners, the likelihood of producing intergeneric hybrids with the genetically remote genus *Dahlia* is incredible. Consequently, when considered along with the absence of any morphological traits derived from *Cosmos*, it is evident that 'Mexican Black' should be regarded as simply a hybrid within *Dahlia*.

Potentilla sensu lato and other Rosaceae

Following the publication of the accounts of *Potentilla* and related genera in *Flora of North America* (Ertter et al. 2014) and the study on Rosaceae phylogeny and classification by Potter et al. (2007), the Royal Horticultural Society's Nomenclature and Taxonomy Advisory Group (NATAG) has recommended for horticultural use the adoption of a narrower concept of *Potentilla* along with acceptance of *Comarum*, *Dasiphora*, and *Drymocallis*. These changes are expected to be adopted in the 2016 edition of the *RHS Plant Finder*. This requires the validation of several new hybrid generic names.

Fragaria × *Dasiphora* = × ***Fragiphora*** J.M.H. Shaw, **nothogen. nov.**
Fragaria × *Drymocallis* = × ***Drymogaria*** J.M.H. Shaw, **nothogen. nov.**
Fragaria × *Potentilla* = × ***Potenaria*** J.M.H. Shaw, **nothogen. nov.**

A name for *Fragaria* × *Comarum* is already available as × *Comagaria* Büscher & G.H. Loos in Veroff. [Bohumer Bot. Ver. 2(1): 6. 2010], along with the combination × *Comagaria rosea* (Mabb.) Büscher & G.H. Loos. [basionym: *Potentilla* × *rosea* Mabb.] specifically to accommodate the cultivar 'Frel,' also sold under the trade designation PINK PANDA.

The opportunity is also taken to provide valid nothogenera for the following hybrid combinations in Rosaceae.

Amelanchier × *Aria* × *Pyrus* = × ***Ariamelyrus*** J.M.H. Shaw, **nothogen. nov.**
Amelanchier × *Aria* × *Sorbus* = × ***Arisorbanchier*** J.M.H. Shaw, **nothogen. nov.**
Aronia × *Mespilus* × *Sorbus* = × ***Mesaronibus*** J.M.H. Shaw, **nothogen. nov.**
Aronia × *Crataegus* × *Sorbus* = × ***Crataronibus*** J.M.H. Shaw, **nothogen. nov.**
Cotoneaster × *Pyracantha* = × ***Cotacantha*** J.M.H. Shaw, **nothogen. nov.**
Cowania × *Fallugia* = × ***Fallania*** J.M.H. Shaw, **nothogen. nov.**
Cydonia × *Pseudocydonia* = × ***Cydocydonia*** J.M.H. Shaw, **nothogen. nov.**
Mespilus × *Sorbus* = × ***Sorbomespilus*** Mezhenskyj ex J.M.H. Shaw, **nothogen. nov.**
Photinia × *Pyracantha* = × ***Photacantha*** J.M.H. Shaw, **nothogen. nov.**
Pyracantha × *Sorbus* = × ***Sorbacantha*** hort. ex J.M.H. Shaw, **nothogen. nov.**

An additional transfer needs to be validated. When establishing the nothogenus × *Tormariosorbus* Mezhenskyj, with the parentage *Aria* × *Sorbus* × *Torminalis*, Mezhenskyj (2012: 28) also intended to provide a new combination based on *Pyrus intermedia* Ehrh. Unfortunately he used the unpublished nothogeneric name × *Sorbotoraria*, evidently for *Aria* × *Sorbus* × *Torminalis*, instead of the name × *Tormariosorbus* that he had just established two lines above on the previous page. Hence the intended combination is here validated.

× **Tormariosorbus intermedia** (Ehrh.) Mezhenskyj ex J.M.H.Shaw, **comb. nov.** Basionym: *Pyrus intermedia* Ehrh., Beitr. Naturk. (Ehrhart) 4: 20. 1789.
Synonym: × *Sorbotoraria intermedia* (Ehrh.) Mezhenskyj in Mezhenskyj et al., Rare Fruit Crops 2012: 29. Nom. inval.

Stylophorum (Papaveraceae)

Stylophorum is a small genus of three species of woodland perennials notable for an East-West disjunction with one species, *S. diphyllum*, from eastern North America and two from China. Investigation of relationships using chloroplast DNA revealed that the American *S. diphyllum* is sister to the remainder of Eurasian *Stylophorum* and *Chelidonium* (Blattner & Kadereit 1995). Recently a spontaneous hybrid between the North American *Stylophorum diphyllum* and the Chinese *Stylophorum lasiocarpum* was discovered adjacent to both parents in the gardens at Crûg Farm Plants, North Wales. It is here provided with a valid name.

Stylophorum × crugianum J.M.H. Shaw, **nothosp. nov.** **TYPE**: N. Wales. Crug Farm, 2014, *Bleddyn Wynn-Jones & J.M.H. Shaw s.n.* (holotype: WSY).

Differs from *Stylophorum diphyllum* by more than 2–4 flowers per cluster, and slender rather than ovoid capsule. Differs from *S. lasiocarpum* by deeply lobulated apical leaf lobe and shorter wider capsules. Perhaps approaches *S. sutchenense* in capsule characters, which invites speculation that it could be a paleohybrid.

Spontaneous garden hybrid with characters intermediate between the parents. Perennial herb to about 50 cm tall, with orange latex. Stems erect, simple, with sparse linear hairs. Leaves several, petiole 3–5 cm long, blade dark green above, glaucous green beneath, ca. 30 cm long x 20–23 cm at widest point, oblong-obovate with 3–4 pairs of lobes and a large terminal trilobulate lobe, 12–14 cm long x 11–13 cm wide; lateral lobes ovate-oblong, 10–14 x 5–6 cm, covered towards leaf apex, margins coarsely crenate, lowermost lobes smaller 5–7 x 2–3.5 cm. Flowers 7–9 in umbel-like, sometimes partly compound, clusters, opening in succession. Bracts 5–10 mm long x 3–4 mm wide, lanceolate, with scattered pubescent hairs. Pedicels 8–13 cm, pubescent. Sepals ovate, 12–18 mm long, exterior pubescent, apex acute. Petals yellow, obovate to orbicular, 3 cm long x 2–2.5 cm wide. Stamens ca. 28, 10–11mm long; anthers yellow, oblong, ca. 2 mm long. Ovary narrow lanceolate, strigilose, ca. 7 mm long; style glabrous, 2–3 mm; stigma bilobed, surface densely pubescent. Capsule pubescent, narrowly oblong-ovate. Figure 1 shows both parents; Figure 2 show the hybrid.

Figure 1. *Stylophorum* parents. *S. diphyllum* above, *S. lasiocarpum* below.

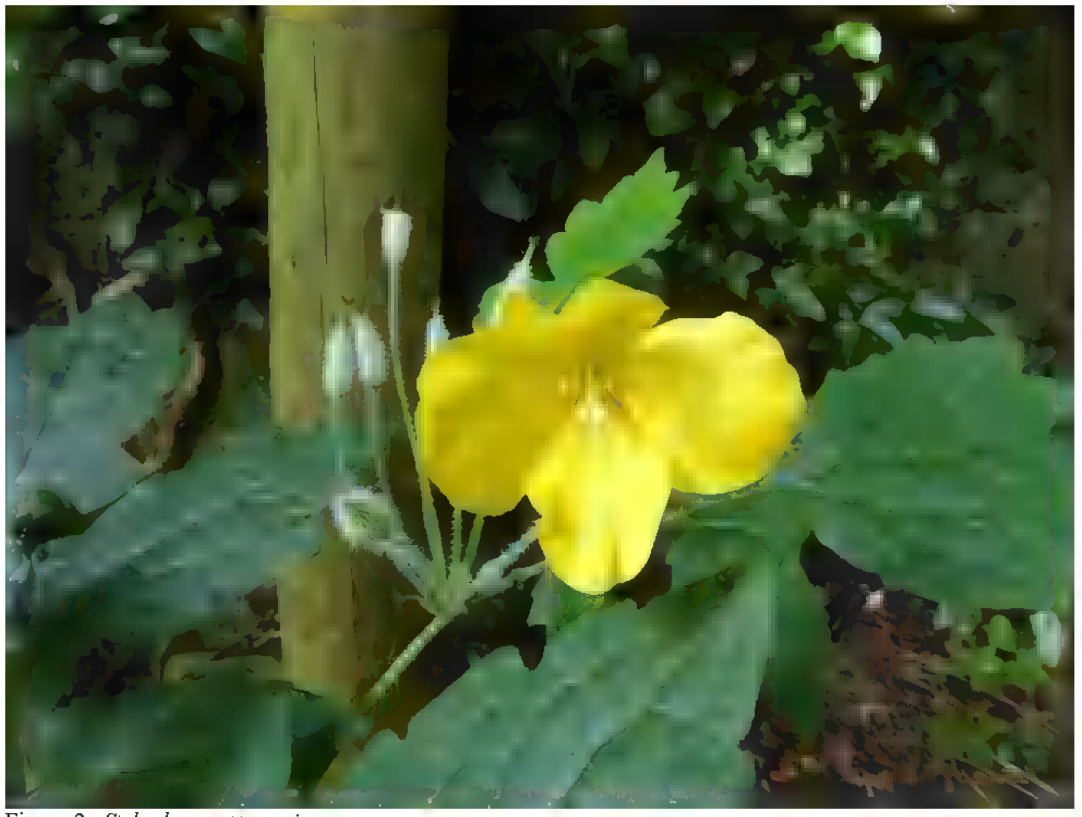

Figure 2. *Stylophorum* × *crugianum*.

Tigridia (Iridaceae)

Since the 1970's a hybrid between *Rigidella orthantha* and *Tigridia pavonia* originally made by Elmer Molseed has been in cultivation in USA, albeit rarely seen in the UK. It was illustrated and informally described by Brian Mathew, who cultivated it in his garden from stock obtained from the USA (Mathew 1978). He also deposited a herbarium specimen at Kew.

At that time *Rigidella* was accepted as a genus distinct from *Tigridia*, although the two genera were regarded as closely related. As Mathew noted, the differences seem to be related to differing pollination requirements of hummingbirds, hence the bright red flowers of *Rigidella* and flies or bees in the muted shades of *Tigridia*. Chilean botanist Pierfelice Ravenna provided new combinations in *Tigridia* for the known *Rigidella* species in a paper on conservation, without any explanation other than observing that *Rigidella* species are more similar to *T. pavonia* than to other *Tigridia* species (Ravenna 1977), a point already noted by Molseed (1970) in his revision of *Tigridia*. Subsequent molecular work has upheld the inclusion of *Rigidella* within *Tigridia* along with several other small Central American genera including, *Ainea*, *Colima*, *Fosteria*, and *Sessilanthera* (Rodriguez & Sytsma 2006; Goldblatt & Manning 2008). Consequently this hybrid is no longer regarded as intergeneric. A name is here provided for use in the horticultural literature.

Tigridia × **mathewii** J.M.H.Shaw, **nothosp. nov.** **TYPE**: Cultivated plant, UK, *B. Mathew s.n.* (holotype: K). Illustration: Mathew, 1978: 125.

Vigorous, sterile hybrid between *T. pavonia* and *T.* (*Rigidella*) *orthantha*. Corm and foliage very similar to *T. pavonia* but with greatly increased bulbil production. Flowers intermediate between parents, held erect with outer tepals scarlet and reflexed as *T. orthantha*, but inner tepals yellow, smaller than *T. pavonia*, but larger than in *T. orthantha*. Tepal bases forming a cup-like structure, as in *T. pavonia*, spotted and blotched scarlet and yellow.

Flowering June to August, but not producing seed. Increasing rapidly by bulbils. Named for Brian Mathew (former Kew botanist), who introduced it to UK cultivation and who made extensive studies in Iridaceae. The hybrid was also mentioned in passing by American bulb enthusiast T.M. Howard (2001), who noted that it is vigorous, showy and infertile.

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CORRECTION: "A NOTE ON *EUGENIA MARITIMA* AND *MYRCIA POLYANTHA* (MYRTACEAE)"

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In a recent paper (Sobral et al. 2015) we found two cases of simultaneous publication of a same name for distinct species by the same author, namely *Myrcia polyantha* DC. / *M. polyantha* (Kunth) DC. and *Eugenia maritima* DC. / *E. maritima* (Kunth) De Candolle (De Candolle 1828: 252, 255, 271, 282 respectively). Nevertheless, we erroneously overemphasized the priority of *Myrtus polyantha* Kunth and *Myrtus maritima* Kunth (1823: 140, 146 respectively) and invoked Article 11.4 (McNeill et al. 2011) for equaling the priority of *Myrcia polyantha* (Kunth) DC. and *Eugenia maritima* (Kunth) DC. back to their basionyms in 1823, while overlooking Article 33.1, which states that "the date of a name is that of its valid publication" (McNeill et al. 2011). Thus, irrespective of the validity of *Myrtus polyantha* and *M. maritima*, the dual names proposed by DC. under *Eugenia* and *Myrcia* have the same date of creation, being not possible to recognize priority back to the Kunthian names. On the other hand, Article 11.5 states that in the case of legitimate names with equal priority the name to be taken is that used by the first author who united them (McNeill et al. 2011). This was made by Steudel (1840-1841) who took the names *Eugenia maritima* DC. and *Myrcia polyantha* DC. as valid and replaced *E. maritima* (Kunth) DC. for *E. acapulcensis* Steud. and *M. polyantha* (Kunth) DC. for *M. kunthiana* Steud. So, we fulfill the unpleasant and embarrassing obligation of admitting our wrong interpretation and here list the valid names for the species considered.

1. *EUGENIA ACAPULCENSIS* Steud., Nomencl. Bot (ed. 2) 1: 601. 1840 [replacement name for *Eugenia maritima* (Kunth) DC., Prodr. 3: 282. 1828, based on *Myrtus maritima* Kunth, Nov. Gen. Sp. 6: 146. 1823]. **TYPE: MEXICO**. "Crescit in maritimis prope Acapulco Mexicanorum," *Humboldt & Bonpland s.n.* (P).

2. *EUGENIA MARITIMA* DC., Prodr. 3: 271. 1828. **TYPE: BRAZIL**. Bahia: "In Brasiliae maritimis ad Ilheos," *Martius s.n.* (M). Not *E. maritima* (Kunth) DC.

   = *Eugenia ilhensis* O. Berg, Linnaea 27: 212. 1856 [nom. illeg.].

3. *MYRCIA POLYANTHA* DC., Prodr. 3: 252. 1828. **TYPE: BRAZIL**. "In Brasiliae campestribus apricis desertis provinciae Bahiensis," *Martius s.n.* (M). Not *Myrcia polyantha* (Kunth) DC.

   = *Myrcia neopolyantha* Sobral & Mazine, Phytoneuron 2015-30: 2. 2015 [nom. illeg.].

4. *MYRCIA SPLENDENS* (Sw.) DC., Prodr. 3: 244. 1828. *Myrtus splendens* Sw., Prodr.: 79. 1788. **TYPE: HISPANIOLA**. *Swartz s.n.* (S).

= *Myrcia polyantha* (Kunth) DC., Prodr. 3: 255. 1828. *Myrtus polyantha* Kunth, Nov. Gen. Sp. 6: 140. 1823. **Type: VENEZUELA.** "Crescit ad ripam fluminis Atabapi, Misiones del Orinoco," *Humboldt & Bonpland s.n.* (P).

= *Myrcia kunthiana* Steud., Nomencl. Bot. (ed. 2) 2: 173. 1841 [replacement name for *Myrcia polyantha* (Kunth) DC.].

ACKNOWLEDGEMENTS

We are greatly indebted to Fred Barrie for pointing out our wrong assumptions.

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CENTAURIUM TENUIFLORUM (GENTIANACEAE) NEW TO ARKANSAS

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ABSTRACT

Centaurium tenuiflorum, a native of Europe, is reported for the first time as naturalized in Arkansas. The species is known to be naturalized in the nearby states of Texas, Oklahoma, Louisiana, and Mississippi as well as in California and Oregon.

Based on the following specimens collected in southern Arkansas, we report *Centaurium tenuiflorum* (Hoffmanns. & Link) Fritsch ex Janch., Figure 1, (Gentianaceae) as new to the spontaneous flora of that state.

Arkansas. Miller Co.: E side of Hwy 49, 0.4 mi S of jct with Arkansas Blvd, slope right-of-way, near Texarkana Airport (33° 27' 15.93" N, 94° 0' 34.36" W), 20 May 2015, *Singhurst 20995* (BAYLU). Saline Co.: N side of I-30, 0.8 mi W of jct with Hwy 67, right-of-way along access road, W side of the weigh station lane (34° 32' 30.34" N, 92° 38' 37.82" W), 27 May 2015, *Keesling* 54 (ANHC); W side of Hill Farm Road 0.8 mi from jct with South Reynolds Road and across from Central Arkansas Flying Club Airport (34° 35' 15.12" N, 92° 29' 10.52" W), 6 Jul 2015, *Keesling* 70 (ANHC).

The *Centaurium tenuiflorum* population in Miller County consisted of several hundred individuals at the base of a slope of an infrequently mowed right-of-way. Associated flora included *Cynodon dactylon*, *Diodia teres*, *Erigeron strigosus*, *Hordeum* sp., *Juncus marginatus*, *Oenothera speciosa*, *Medicago* sp., *Plantago aristata*, *Trifolium* spp., and *Verbena halei*. The first Saline County population (*Keesling 54*) included about 20 individuals in a disturbed right-of-way with *Daucus carota*, *Oenothera linifolia*, *Plantago aristata*, *Trifolium arvense*, *Verbena incompta*, and *Verbena halei*. Aside from *C. tenuiflorum*, the second Saline County location (*Keesling 70*) was characterized by *Coreopsis* sp., *Krigia caespitosa*, *Kummerowia striata*, *Plantago aristata*, and *Paspalum notatum*.

Centaurium tenuiflorum was reported in Texas, Louisiana, and Mississippi (Holmes & Wivagg 1996) under the name *Centaurium muehlenbergii* (Griseb.) W. Wright ex Piper. Use of this name was based upon Hickman (1993), where *C. tenuiflorum* is listed as a synonym of *C. muehlenbergii*. However, Pringle (2010) has identified *C. muhlenbergii* as being *Zeltnera muehlenbergii* (Griseb.) G. Mansion, a North American species native from southern California to southwestern British Columbia.

Centaurium tenuiflorum is native to western and southern Europe. It has been naturalized in California and Oregon and in Texas, Oklahoma, Louisiana, and Mississippi (summarized by Mink et

al. 2011). The species tends to be "weedy," occurring in pastures, waste places, disturbed areas, and roadsides. It has been confused with *Zeltnera texense* (Griseb.) G. Mansion, especially in Texas, but may be distinguished by its habitat preference (weedy areas), robust size (generally 30 cm or taller), flat-topped corymb, and more or less sessile flowers. *Zeltnera texense* normally occurs on eroded limestone, has a more open and paniculate inflorescence, is normally less than 20 cm tall (but occasionally up to 30 cm), and has pedicels that are about the same length as the calyces.

Fig. 1. *Centaurium tenuiflorum* from Saline Co., Arkansas. Photo by Jim Keesling, 27 May 2015.

ACKNOWLEDGEMENTS

The authors are grateful to Theo Witsell, Senior Botanist/Ecologist with the Arkansas Natural Heritage Commission, for his suggestions and review of this manuscript.

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NOTHOSCHKUHRIA, A NEW SOUTH AMERICAN GENUS FOR *SCHKUHRIA DEGENERICA* (COMPOSITAE, BAHIEAE)

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ABSTRACT

Nothoschkuhria B.G. Baldwin, **gen. nov.**, is based on *Schkuhria degenerica* (Kuntze) R.E. Fr., now treated as **Nothoschkuhria degenerica** (Kuntze) B.G. Baldwin, **comb. nov.**, of dry highlands in Bolivia and northern Argentina. Morphologically, the monotypic *Nothoschkuhria* differs in part from all other genera of Bahieae (including *Schkuhria* Roth) by a combination of annual habit, non-impressed glandular foliage, strictly alternate and bi- or tri-ternately parted leaves, discoid heads with 30+ florets, narrowly obpyramidal cypselae that are more densely strigulose proximally than distally, and pappi of 8 scales. Molecular phylogenetic data for Bahieae corroborate C.B. Heiser's suggestion that the taxon treated here as *Nothoschkuhria* is more closely related to *Bahia* Lag. than to *Schkuhria*. Treatment of *Nothoschkuhria* and *Bahia* in a monophyletic genus would require expanding the circumscription of *Bahia* to include other, more disparate genera.

Molecular phylogenetic analyses of Bahieae (Compositae, Heliantheae alliance) including representatives of more taxa than were studied by Baldwin et al. (2002) have revealed that *Schkuhria* Roth as circumscribed in recent treatments is polyphyletic (B.G. Baldwin & K.R. Wood, in prep.). Based on those findings, the South American *S. degenerica* (Kuntze) R.E. Fr. represents a separate lineage that does not constitute a monophyletic group with typical members of *Schkuhria* to the exclusion of other genera of the mostly southwestern North American "*Bahia* clade" (Baldwin et al. 2002) and additional genera not sampled in previously published phylogenetic studies (B.G. Baldwin & K.R. Wood, in prep.). Those findings and morphological considerations warrant treatment of *S. degenerica* in a genus distinct from others in Bahieae.

NOTHOSCHKUHRIA B.G. Baldwin, **gen. nov.** **TYPE**: *Nothoschkuhria degenerica* (Kuntze) B.G. Baldwin.

From other genera of Bahieae, *Nothoschkuhria* differs by the combination of annual habit, foliage with non-impressed glands, leaves strictly alternate and with blades bi- or tri-ternately parted, heads discoid, florets 30+ florets, cypselae narrowly obpyramidal and more densely strigulose proximally than distally, and pappi of 8 scales.

Annuals, decumbent to erect, 1–4 dm tall, openly branched from base or distally, foliage hispid-hirsute and stipitate- and sessile-glandular, the glands not impressed. **Leaves** alternate throughout, proximals petioled, petioles to 5 cm long, blades mostly bi- or tri-ternately parted, blades usually ovate to cordate in outline, 5–25 mm long, ultimate lobes linear, usually < 1 mm wide. **Capitulescences** open, paniculiform, peduncles 5–20 mm long. **Heads** discoid. **Involucres** obconic to turbinate, < 1 cm diam. **Phyllaries** 5–7, in ± 1 series, subequal, narrowly to broadly obovate, herbaceous, margins scarious, at least apically, apices yellow or reddish, abaxial faces stipitate- and sessile-glandular, the glands not impressed. **Receptacles** epaleate. **Florets** bisexual, fertile, ca. 30–40, corollas yellow, sometimes red-tipped, ca. 2–3 mm long, tubes shorter than or equaling narrowly funnelform throats, lobes 5, deltate. **Cypselae** black, narrowly obpyramidal, 4-angled, black,

strigulose, more densely proximally, especially on angles, 3–5 mm long; pappi of 8 persistent, elliptic to oblanceolate or spatulate, basally and medially thickened, laterally scarious, maroon to reddish-purple flecked scales, ca. 2 mm long, the alternate ones aristate, aristae ca. 0.5–1 mm long.

The name *Nothoschkuhria* reflects past misassociation of this taxon with *Schkuhria*. In his revision of *Schkuhria*, Heiser (1945) retained *S. degenerica* in *Schkuhria* but noted that all species except those later treated by Turner (1995) in a broadly circumscribed *S. pinnata* (Lam.) Kuntze ex Thell. were not "true Schkuhrias" and were more closely related to taxa of *Bahia* Lag. Based on molecular phylogenetic data (B.G. Baldwin & K.R. Wood, in prep.), *Nothoschkuhria degenerica* (≡ *S. degenerica*) is evidently more closely related to *Bahia* than to *Schkuhria* sensu stricto, as Heiser suggested. Treating *Bahia* and *Nothoschkuhria* together in a monophyletic genus would require expanding the circumscription of *Bahia* to include other morphologically distinct genera of the "*Bahia* clade" sensu Baldwin et al. (2002) and more disparate genera not previously included within that clade (B.G. Baldwin & K.R. Wood, in prep.).

Nothoschkuhria contains only one species, which is known from dry highlands of Bolivia and northern Argentina, mostly from 2250 to 3770 m elevation. Flowering specimens examined were collected in March and April.

Nothoschkuhria degenerica (Kuntze) B.G. Baldwin, **comb. nov.** *Rothia degenerica* Kuntze, Revis. Gen. Pl. 3: 169. 1898. *Schkuhria degenerica* (Kuntze) R.E. Fr., Ark. Bot. 5: 22. 1906. **TYPE: BOLIVIA.** On the Rio Tapacari, 3000 m, 19 Mar 1892, *O. Kuntze s.n.* (holotype: NY, as image in JSTOR; isotype: B destroyed).

Heiser (1945) noted two earlier names, not validly published, in synonymy of *Schkuhria degenerica*: (1) *Schkuhria pusilla* Wedd. var. *major* Sch.Bip., Bull. Soc. Bot. France 12: 80. 1865; Linnaea 34: 529. 1866 (nomen nudum); (2) *Schkuhria oölepis* Sch.Bip., loc. cit. (nomen nudum).

ACKNOWLEDGEMENTS

I thank Guy L. Nesom and John L. Strother for reviewing the manuscript, Bridget L. Wessa for technical assistance, and the National Tropical Botanical Garden and the Lawrence R. Heckard Fund of the Jepson Herbarium for financial support. [Minor correction to Abstract: 27 Oct 2015]

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Rodríguez, D. 2015. *Liabum bourgeaui* y *Zinnia peruviana* (Asteraceae), nuevos registros para la flora de El Salvador. Phytoneuron 2015-57: 1–3. Published 20 October 2015. ISSN 2153 733X

LIABUM BOURGEAUI Y *ZINNIA PERUVIANA* (ASTERACEAE), NUEVOS REGISTROS PARA LA FLORA DE EL SALVADOR

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RESUMEN

Se dan a conocer a *Liabum bourgeaui* y *Zinnia peruviana* como nuevos registros para la flora de El Salvador, el presente artículo, se acompaña de imágenes de las muestras botánicas y mapa de localidad de los hallazgos.

ABSTRACT

Liabum bourgeaui and *Zinnia peruviana* are reported as new records for the flora of El Salvador. Images of representative specimens and a map location of the collections are provided.

En la segunda edición notablemente corregida y aumentada de La Lista Preliminar de Plantas de El Salvador por el Dr. Salvador Calderon e Ing. Agr. Paul C. Standley de (1941), mencionan para El Salvador a *Liabum glabrum* var. *hypoleucum* Greenm., "Papelillo," "Espinillo," "Palo de San Nicolas." De los departamentos centrales y occidentales, refiriéndose a un arbusto o árbol de 2–6 m, de flores amarillas y hojas blancas por abajo. Además menciona a *L. subglandulare* Blake, del departamento de Santa Ana, mencionando que es un arbusto o árbol de 3–6 m, con flores amarillas. También *Zinnia elegans* Jacq., "Cambray," "Margarita," como una planta ornamental de los Jardines, naturalizada en algunas partes. Originaria de México.

En la obra especies útiles de La Flora Salvadoreña, el Dr. Guzmán menciona a *Zinnia elegans* Jacq. y se refiere a la especie como bellas plantas cultivadas en todos los jardines y que proceden de México, hace una descripción corta de la especie. También menciona que por el cultivo las zinnias modifican sus capítulos en forma y tamaño, variando sus colores rojo, amarillo, y violeta. Las más bonitas especies son *Z. mexicana*, *Z. multiflora*, y *Z. angustifolia*.

La literatura consultada da a conocer que El Salvador es el único país en la región de Centro América donde aún no se han reportado ambas especies (Pruski 2015; Robinson 2015), los nuevos reportes contribuyen y aumentan la distribución en la región. Se verificaron los ejemplares de muestras botánicas de *Liabum* y *Zinnia* en los herbarios LAGU y MHES (Herbario Museo de Historia Natural de El Salvador)

LIABUM BOURGEAUI Hieron., Verh. Bot. Vereins Prov. Brandenburg 48: 208. 1907.

Material examinado. **EL SALVADOR. Ahuachapán.** Mpio. San Francisco Menéndez, San Benito, P.N. El Imposible, al este de la Montaña de Tacho López, (13° 49' N y 89° 56' W), 11 Feb 1992 (fl.), *Sandoval & Chinchilla 00262* (B, K, LAGU, MO); Río Mashtapula, al W de la cabecera, (13° 49' N y 89° 56' W), 26 Feb 1993 (fl), *Sandoval & Sandoval 01071* (B, K, LAGU); **Santa Ana.** Mpio. Metapán, Ctón. San José Ingenio, P.N. Montecristo, Los Planes, Quebrada Las Huertas, (14° 23' 37" N y 89° 22' 0" W), 29 Abr 2015 (fl.), *Rodríguez, López, & Magaña 05201* (LAGU, MO). Figure 2.

Distribución y hábitat. Desde el sur de México a Panamá. En El Salvador ocurre en la Zona Occidental en sitios de Bosque tropical semideciduo mixto submontano, bien drenado MARN 2011), a elevaciones de 1770 m.s.n.m. Figure 1.

Fenología. Florece de Febrero a Abril.

ZINNIA PERUVIANA (L.) L., Syst. Nat. (ed. 10) 2: 1221. 1759.

Material examinado. **EL SALVADOR. Santa Ana**. Mpio. Chalchuapa, Crio. El Jute, A.N.P. La Magdalena, Sector Cerro Mala Cara, cumbre del cerro, (13° 4' 52" N y 89° 41' 23" W), 22 Oct 2012 (fl.), *Rodríguez, Nolasco, & Marciano 03640* (LAGU, MO); Mpio. Candelaria de La Frontera, Ctón. La Criba, Cima de Cerro Caballito, (14° 6' 19" N y 89° 40' 37" W), 2 Sep 2014 (fl.), *Galán & Torres 03045* (B, LAGU, MEXU, MO). Figure 2.

Distribución y hábitat. Desde México a Sudamérica. En El Salvador ocurre en la Zona Occidental en sitios de Bosque tropical deciduo latifoliado de tierras bajas, bien drenado (MARN 2011), en pequeños pastizales en zonas rocosas, a elevaciones de 838-1087 m.s.n.m. Fig. 1.

Fenología. Florece y fructifica de Septiembre a Noviembre

AGRADECIMIENTOS

Agradezco al personal de guarda-recursos del P.N. El Imposible, A.N.P. La Magdalena, y del P.N. Montecristo por el invaluable trabajo que realizan y la asistencia en campo para el encuentro de los nuevos reportes; también al personal del herbario MHES por la asistencia brindada.

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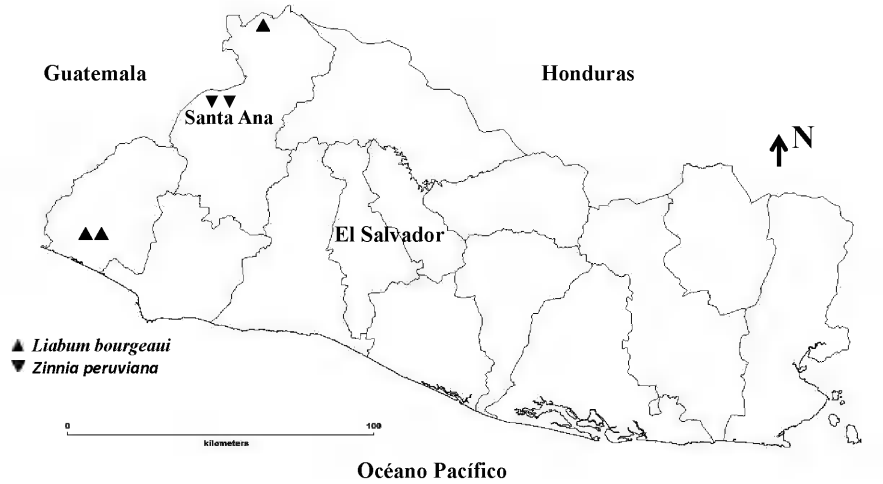

Figure 1. Distribución local de *Liabum bourgeaui* y *Zinnia peruviana* en El Salvador.

Figure 2. Asteraceae. A) *Liabum bourgeaui*, B) *Zinnia peruviana*.

Felger, R.S. and S. Rutman. 2015. Ajo Peak to Tinajas Altas: a flora of southwestern Arizona. Part 14. Eudicots: Fabaceae – legume family. Phytoneuron 2015-58: 1–83. Published 20 Oct 2015. ISSN 2153 733X

AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA. PART 14. EUDICOTS: FABACEAE – LEGUME FAMILY

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ABSTRACT

A floristic account is provided for the legume family (Fabaceae) as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the heart of the Sonoran Desert of southwestern Arizona. This flora includes 47 legume species in 28 genera, which is 6% of the total local vascular plant flora. These legumes are distributed across three subfamilies: Caesalpinioideae with 7 species, Mimosoideae 9 species, and Papilionoideae 28 species. Organ Pipe includes 38 legume species, Cabeza Prieta 22 species, and Tinajas Altas 10 species. Perennials, ranging from herbaceous to trees, account for 49 percent of the flora, the rest being annuals or facultative annuals or perennials and mostly growing during the cooler seasons.

This publication, encompassing the legume family, is our fourteenth contribution to the vascular plant flora in southwestern Arizona. The flora area covers 5141 km^2 (1985 mi^2) in the Sonoran Desert (Figure 1). These contributions are published in Phytoneuron and also posted on the website of the University of Arizona Herbarium (http://cals.arizona.edu/herbarium/content/flora-sw-arizona).

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. Fossil specimens are indicated with a dagger symbol (†). Non-natives not established (not reproducing) in the flora area are marked with double asterisks (**) and the one non-native species with an established population is marked with an asterisk (*). In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish, and the Hia-Ced O'odham dialect, respectively (see Felger 2007a and Felger et al. 1992 for usage of Hia-Ced O'odham plant names). Spanish-language names are italicized. The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that such quantitative values are, to varying degrees, seldom exact.

All photos and scans are by Sue Rutman unless otherwise stated and botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986) unless otherwise stated. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2014). We have

seen specimens or images of all specimens cited. When no collection number is provided, the specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Additional explanation of the format for this flora series is provided in Part 3 of this flora series (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

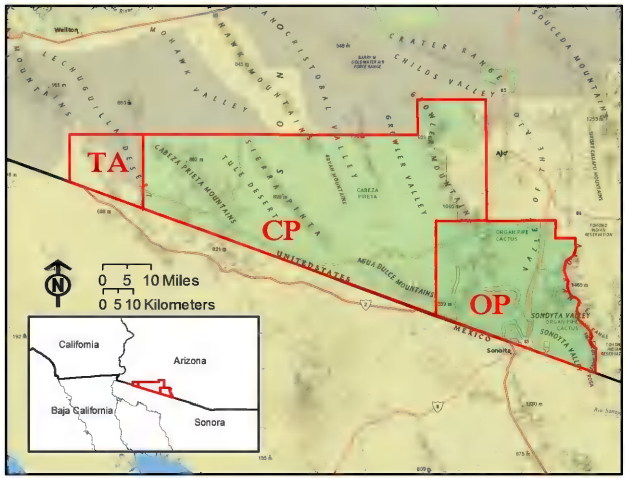

Figure 1. Flora area in southwestern Arizona. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Green shading indicates approximate boundaries of federally designated wilderness.

FABACEAE (LEGUMINOSAE) – Legume Family

Annual or perennial herbs, shrubs, trees, or vines, many with nitrogen-fixing bacteria in root nodules. Leaves and branches usually alternate. Leaves once or twice pinnately compound, often with pulvini at base of petioles, pinnae, and individual leaflets. (Pulvini are swollen areas, often dark or differently colored, that swell or contract to open or close leaf parts, often in response to water stress and night-day cycles; pulvini may sometimes be present but not functional.) Stipules usually present, often well developed and persistent. Flowers usually bisexual and 5-merous. Sepals usually 5 and united. Petals mostly 5, often separate. Stamens mostly 5 or 10 to numerous. Pistil single, superior, simple (1 carpel), the ovules attached along one side. Fruit usually a pod, highly diverse in morphology, dry and dehiscent (opening) along one or both edges, or indehiscent and often with mealy or fleshy pulp. Seeds 1 to many, often long-lived, the seed coat often hard and impervious to water and air (scarification, i.e., nicking or abrading the seed coat, enhances germination).

Worldwide with 3 subfamilies, 650 genera, 16,500 species. There are 47 species of legumes in 28 genera in the flora area (Table 1). Four species are not native to the region, and only one, *Melilotus indicus,* is established in the flora area. The Sonoran Desert flora includes 281 legume species (estimate modified from Wiggins 1964), or about 11% of the total Sonoran Desert flora. Legume species make up only 6.5% of the flora of southwestern Arizona (726 species, based on our original checklist (Felger et al. 2013) and 12 subsequent additions). In comparison, legumes make up only 5% of the flora of the Gran Desierto in adjacent northwestern Sonora (34 species of 668 total native and non-native species; Felger 2000). The Organ Pipe flora includes 38 legume species (3 of them not established as reproducing populations), Cabeza Prieta 22 species, and only 10 occur in the hyper arid Tinajas Altas Region (Table 1). The subfamilies with their genera are listed below with the number of species in the flora area in parentheses (for genera with more than one species).

Subfamily **Caesalpinioideae**. Trees, shrubs, and herbs in the flora area; seldom nitrogen-fixing. Leaves once or twice pinnate. Flowers often showy, bilaterally symmetrical but often not conspicuously so. Stamens usually 10, mostly separate. Largely of tropical or subtropical origin: *Chamaecrista, Hoffmannseggia* (2), *Parkinsonia* (3), and *Senna*.

Subfamily **Mimosoideae**. Trees and shrubs (in the flora area), mostly nitrogen-fixing. Leaves usually twice pinnate; leafstalks often with crateriform or cup-shaped nectary glands, the center often raised and nectar filled when fresh, later becoming sunken. Flowers radial except the pistil, mostly sessile or nearly so, and close together in spikes, heads, and racemes. Stamens usually 10 or numerous, usually much longer than the petals and forming the showy part of the flower, the anthers small and often with a deciduous gland at the tip of the tissue connecting the 2 anther cells. Mostly tropical and subtropical: *Acaciella, Calliandra, Mimosa, Prosopis* (3), *Senegalia*, and *Vachellia* (2).

Subfamily **Papilionoideae**. Annual to perennial herbs, vines, shrubs, or trees, almost all nitrogen-fixing. Leaves pinnately or digitately once compound or simple. Flowers bilaterally symmetrical. Upper petal (banner or standard) flanked by 2 lateral petals (wings), the 2 lower petals coalesced into a boat-shaped structure (keel) enclosing the stamens and style. Stamens mostly 10; monodelphous, the filaments united into a tube, or diadelphous, with 1 free stamen and the others with filaments united into a tube surrounding the ovary. Tropical to temperate: *Acmispon* (4), *Astragalus* (4), *Coursetia, Dalea* (3), *Desmodium, Galactia, Lupinus* (3), *Marina, *Medicago, *Melilotus, Nissolia, Olneya, Phaseolus* (2), *Psorothamnus* (3), *Rhynchosia, Tephrosia, Trifolium*, and *Vicia*.

Legumes rival the grass family in economic importance worldwide, providing food, forage and fodder, dye, fiber, medicine, and timber. Major legume food and fodder crops include alfalfa, beans, clover, peanuts, peas, and soybeans, all of which are papilionoids. Several legumes in the flora area featured importantly in the economies of local Sonoran Desert people: ironwood (*Olneya*), foothill palo verde (*Parkinsonia microphylla*), desert and tepary beans (*Phaseolus acutifolius* and *P. filiformis*), mesquite (*Prosopis glandulosa/P. velutina*), and screwbean (*Prosopis pubescens*) (e.g., Bell & Castetter 1937; Castetter & Bell 1942, 1951; Felger 2000, 2007a, 2007b; Felger & Moser 1985; Felger et al. 1992; Rea 1997). Legumes form important components of the local desert vegetation. The most abundant and important larger legumes in the local vegetation are *Olneya tesota, Parkinsonia* spp., *Prosopis glandulosa*, and *P. velutina.* These large Sonoran Desert legumes are important nurse plants for an array of herbs, shrubs, and larger perennials including columnar cacti.

Table 1. Local distributions and growth forms of legumes in southwestern Arizona. † = Fossil and modern specimens; * = non-native; ** = non-native species not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = Summer/warm-season ephemerals; WI = winter-spring/cool-season ephemerals; NS = non-seasonal ephemerals; PR = perennials. Totals are for the modern, established flora.

Species	Region			Growth Form			
				Ephemerals			
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter	Non-seasonal	Perennials
Acaciella angustissima	OP						PR
Acmispon brachycarpus	OP				WI		
Acmispon maritimus	OP	CP			WI		
†Acmispon rigidus	OP	CP	TA				PR
Acmispon strigosus	OP	CP	TA		WI		
†Acmispon sp./spp.	(OP)						
Astragalus didymocarpus	OP				WI		
Astragalus insularis		CP			WI		
Astragalus lentiginosus	OP				WI		
Astragalus nuttallianus	OP	CP			WI		
†Astragalus sp.	(OP)						
Calliandra eriophylla	OP	CP					PR
Chamaecrista nictitans	OP			SU			
Coursetia glandulosa	OP						PR
Dalea mollis	OP	CP	TA			NS	
Dalea pogonathera	OP						PR
Dalea pringlei	OP						PR
Desmodium procumbens	OP			SU			
Galactia wrightii	OP						PR
Hoffmannseggia glauca		CP					PR
Hoffmannseggia microphylla			(TA)				(PR)
Lupinus arizonicus	OP	CP	TA		WI		
Lupinus concinnus	OP	CP			WI		
Lupinus sparsiflorus	OP				WI		
†Lupinus sp./spp.	(OP)		(TA)				
†Marina parryi	OP	CP				NS	
***Medicago polymorpha*	(OP)					(NS)	
**Melilotus indicus*	OP					NS	
Mimosa distachya	OP						PR
Nissolia schottii	OP						PR
†Olneya tesota	OP	CP	TA				PR
***Parkinsonia aculeata*	(OP)						(PR)
†Parkinsonia florida	OP	CP	TA				PR

†*Parkinsonia microphylla*	OP	CP	TA				PR
Phaseolus acutifolius	OP			SU			
Phaseolus filiformis	OP	CP				NS	
Prosopis glandulosa		CP	TA				PR
†*Prosopis glandulosa* &/or *P. velutina*	(OP)		(TA)				(PR)
Prosopis pubescens	OP						PR
Prosopis velutina	OP	CP					PR
Psorothamnus emoryi		CP					PR
Psorothamnus fremontii			TA				PR
Psorothamnus spinosus	OP	CP					PR
Rhynchosia texana	OP						PR
†*Senegalia greggii*	OP	CP	TA				PR
†*Senna covesii*	OP	CP					PR
Tephrosia tenella	OP						PR
Trifolium wormskioldii	OP				WI		
†*Vachellia constricta*	OP	CP					PR
***Vachellia farnesiana*	(OP)	(CP)					(PR)
Vicia ludoviciana	OP				WI		
Totals: 43	38	22	10	3	12	4	24

KEY TO THE GENERA

1. Trees or woody shrubs, mostly more than 1 m tall (ambiguous cases key out in both places).

2. Small shrubs 1.5 m or less in height, unarmed (no spines or thorns).

3. Leaves twice pinnate; flowers mimosoid, whitish to pinkish…….. **Calliandra**
3. Leaves once pinnate; flowers papilionoid, various colors.

4. Leaves sparsely pubescent, becoming glabrate, not gland-dotted and not staining yellow; flowers white with yellow and pink; pods dehiscent, multiple-seeded…….. **Coursetia**
4. Herbage densely hairy, gland-dotted, often staining yellowish or orange when rubbed or crushed; flowers blue or purplish; pods indehiscent, 1(2)-seeded.
…… **Psorothamnus emoryi, P. fremontii**

2. Large shrubs or trees, usually more than 2 m tall; armed with spines or thorns or the twigs thorn-tipped (individual branches sometimes unarmed).

5. Bark green, at least on upper limbs; flowers caesalpinioid…….. **Parkinsonia**
5. Bark not green (except sometimes on first or second year's growth); flowers mimosoid or papilionoid.

6. Leaves once pinnate, unifoliolate ("simple") or plants leafless or essentially so; flowers papilionoid.

7. Bark smooth, the trunk not massive; leafless or with few, scattered, simple (unifoliolate) leaves; branchlets sharp-pointed (spinescent) but otherwise unarmed. ..... **Psorothamnus spinosus**
7. Bark shredding, the trunk often massive; branches leafy, the leaves pinnate, with prominent spines at base of at least some leaves..... **Olneya**

6. Leaves twice pinnate; flowers mimosoid.

8. Spines between nodes, recurved, usually laterally compressed, and single (not paired); mature pods conspicuously flattened (more than twice as wide as thick) and dehiscent.

9. Leaves (3.5) 6–8 cm long, with 2–4 pairs of pinnae; flowers lavender-pink; stamens 10 or fewer; pods 4–5.5 × 1 cm wide, separating into 1-seeded segments..... **Mimosa**
9. Leaves 2.5–3.5 cm long, with 2–3 pairs of pinnae; flowers pale yellow; stamens numerous, more than 10; pods (3.5) 6–15 × 1–2+ cm, gradually dehiscent, not separating into segments..... **Senegalia**

8. Spines at nodes (not between nodes), straight, round in cross-section, usually paired; pods terete or nearly so (if somewhat flattened, then less than twice as wide as thick), dehiscent or indehiscent.

10. Shrubs to trees often more than 5 m tall; leaves with 1 or 2 pairs of pinnae; stamens 10; pods (7) 10–20 cm long, or tightly coiled, indehiscent..... **Prosopis**
10. Shrubs to 4 m tall; leaves with 2–6 pairs of pinnae; stamens more than 10; pods to 7.5 cm long (not coiled), gradually dehiscent (or sometimes indehiscent in *V. farnesiana*). ..... **Vachellia**

1. Herbaceous annuals and perennials, not woody (ambiguous cases included if stems not rigid and woody).

11. Vines, the stems not self-supporting; flowers papilionoid.

12. Annuals.

13. Plants without tendrils; leaflets 3..... **Phaseolus**
13. Leafstalk (rachis) ending in a tendril, the leaflets paired, 4 or more..... **Vicia**

12. Perennials.

14. Leaves with 5 leaflets; pods indehiscent, and 1-seeded (samaras)..... **Nissolia**
14. Leaves with 3 leaflets; pods dehiscent with 2 or more seeds.

15. Leaflets mostly widest at about the middle, not gland dotted; flowers pinkish, in raceme-like inflorescences much longer than the leaves; pods multiple-seeded..... **Galactia**
15. Leaflets mostly widest below the middle, the lower surfaces densely dotted with minute golden glands (use magnification); flowers yellow, in small clusters shorter than the leaves; pods 2-seeded..... **Rhynchosia**

11. Not vines.

16. Perennials (note that *Dalea* and *Marina* have annual and perennials species and key in both couplets).

17. Leaves twice pinnate.

18. Slender-stem shrubs more than 50 cm tall; without reddish glands; flowers in nearly rounded heads, mimosoid, white with a pinkish tinge; pods 4–6 cm long..... **Acaciella**
18. Herbaceous perennials to 30 cm tall; with stalked reddish glands on herbage, inflorescences and pods; flowers in racemes, caesalpinioid, yellow; pods 2.5–3 cm long. ..... **Hoffmannseggia glauca**

17. Leaves once pinnate.

19. Leaves even-pinnate with (4) 6 (8) leaflets; flowers caesalpinioid, the anthers large, with terminal pores..... **Senna**
19. Leaves somewhat palmate with 3–5 leaflets, or odd-pinnate with 9–23 leaflets; flowers papilionoid, the anthers small, without terminal pores.

20. Leaflets 3–5; herbage not gland-dotted; flowers yellow; pods more than 20 mm long, dehiscent, the valves rolled up after dehiscence, with more than 2 seeds. ..... **Acmispon rigidus**
20. Leaflets 9–23; herbage gland-dotted; flowers blue to purple, pods 1.8–2.5 mm long, indehiscent, 1-seeded.

21. Flowers subtended by bracts remaining with the open flowers; calyx lobes or teeth (awns) longer than the calyx tube ..... **Dalea**
21. Flowers subtended by bracts falling away before the flower opens; calyx teeth markedly shorter than the tube ..... **Marina**

16. Obviously annuals; flowers papilionoid.

22. Leaves all with 3 leaflets.

23. Leaflets sessile; flowers in compact, bracteate, head-like clusters, the bracts conspicuous and spinose..... **Trifolium**
23. At least the terminal leaflet on a slender stalk; flowers 1–few or in racemes, not in head-like clusters, the bracts inconspicuous or absent.

24. Flower stalks not longer than the leaves; pods coiled and bur-like, several-seeded..... **Medicago**
24. Flower stalks generally much longer than the leaves; pods ovoid and smooth, 1-seeded..... **Melilotus**

22. Most or all leaves with 5 or more leaflets.

25. Leaves digitately compound..... **Lupinus**
25. Leaves pinnately compound.

26. Herbage conspicuously gland-dotted; pods 2.5–3 (4) mm long, 1-seeded.

27. Flowers subtended by bracts remaining with the open flowers; calyx lobes or teeth (awns) longer than the calyx tube ..... **Dalea**
27. Flowers subtended by bracts falling away before the flower opens; calyx teeth markedly shorter than the tube ..... **Marina**

26. Herbage not gland-dotted; pods 4 mm or more in length, with 2 or more seeds.

28. Leaves with (3) 5–7 leaflets; stipules represented by small, dark glands; flowers yellow or orange and red, solitary or in umbels…….. **Acmispon**
28. Leaves with 7–25 leaflets; stipules not gland-like; flowers lavender or purple and white, in racemes (1–3 in *Astragalus nuttalliamus* and sometimes appearing umbellate).

29. Pods indehiscent (gradually or partially dehiscent in *A. nuttalliamus* but the valves do not separate and twist); widespread…….. **Astragalus**
29. Pods dehiscent, the valves twisting after opening; Ajo Mts…….. **Tephrosia**

Acacia, see **Acaciella**, **Senegalia**, and **Vachellia**

The genus *Acacia* sensu lato, the second largest in the legume family (after *Astragalus*), includes some 1300 species worldwide: Australia (957 species), Americas (185 species), Africa (144 species), and Asia (89 species). The type of *Acacia* is generally considered to be *A. scorpioides* (Linnaeus) W.F. Wight (= *A. nilotica* (Linnaeus) Willdenow ex Delile), a species of tropical Africa and western Asia. The classic *Acacia* genus is polyphyletic, calling for generic reassignments. Australian botanists wanted to reserve the name *Acacia* for their species in order to avoid nearly 1000 nomenclatural new combinations. In a decidedly political, albeit practical (depending on where you live and work), taxonomic coup on the part of Australian botanists, the genus *Acacia* became a conserved name applied only to Australian species (e.g., Brummitt 2004; Orchard & Maslin 2005)—unless you decide not to recognize splitting of the genus. Seeming to take a cue from the U.S. Congress, the proposal was presented and voted on in the late afternoon of the last day of a multi-day meeting after most of the participants had gone home. That proposal, to retypify *Acacia* Miller from an African to an Australian type by the Committee for Spermatophyta, was ratified at the final closing session of the XVIIth International Botanical Congress held in Vienna, Austria, in July 2005. That binding change by the Committee to the International Code of Botanical Nomenclature has been highly contentious (e.g., Brummitt 2011; Cameron 2006; Kull & Rangan 2012; Luckow et al. 2005).

In their "Science, sentiment and territorial chauvinism in the acacia name change debate," Kull and Rangan (2012: 215) provided useful insights into this case and its wider implications for biological taxonomy:

> "As Helmreich (2005: 119) points out in the case of naming the algae species found around Hawaii, 'it is ironic that, through oral traditions, the Hawaiian names have been perpetuated and usually *accurately applied* to the individual species, whereas three-fourths of the scientific names have been changed in the past 90 years'. The living scientific name for *Acacia* is *Acacia* in its broad sense, regardless of whether it is properly classified according to the rules of cladistics or any other system. This, in part, is why the acacia name change has generated such furor and emotion among members of the international botanical community and generated outpourings of sentiment among non-botanists in Australia, Africa and many other parts of the world.
>
> Brummitt (2010, 2011) noted that the unprecedented uproar over the acacia name required unconventional approaches to taxonomic rules so as to accommodate cases where particular plant names are associated with strong sentiments. While he suggests that bending the rules this one time would be 'unlikely to impact on other names in the future' (2010: 1925), we suggest that aesthetic sentiments, territorial chauvinisms, and personal agendas will always play a role in debates over classification and nomenclature. Molecular systematics has put many plant classifications, and hence names, under pressure, as have other scientific advances in the past and as others will no doubt do in the future. The crises that result, for acacia and other names, may only be truly resolved by finding ways to recognize and incorporate people's feelings for sounds,

> places and traditions in plant names – even in Latin names. Denying their importance by invoking the pretext of 'scientific objectivity' will only undermine the ability of the International Code of Botanical Nomenclature to serve as a universal system into the future."

Acaciella

Herbaceous perennials, shrubs, and trees; flowers mimosoid. A Neotropical genus of 15 species, segregated from *Acacia*.

Acaciella angustissima (Miller) Britton & Rose
[*Mimosa angustissima* Miller. *Acacia angustissima* (Miller) Kuntze]
White-ball acacia. Figure 2.

Attractive, slender-stem shrubs to 2 m tall, woody below, unarmed (without spines or thorns), growing with warm weather, winter dormant. Leaves (8) 10–16 cm long, bipinnate, larger leaves with 7–11 pairs of pinnae and many small leaflets; often sparsely hirsute or glabrous or essentially so, especially with age; without leafstalk glands. Stipules inconspicuous. Flowers in nearly rounded heads, white, sometimes with a pinkish tinge; stamens numerous (perhaps as many as 100), white, and separate; flowering at least May to August. Pods 4–6 cm long, multiple seeded, dry at maturity without mesocarp, the valves thin and rather papery, and gradually dehiscent.

Ajo Mountains in canyons and rocky slopes to peak elevations, but generally not on the more arid slopes. This is the western limit for the species; the nearest populations are in the Sauceda and Baboquivari mountains.

This species ranges across much of southern USA to Missouri and southward to Central America.

Isely (1998) recognized three varieties of *Acacia angustissima* in Arizona, and Benson and Darrow (1981) recognized two. Plants in Organ Pipe and nearby areas most nearly fit Isely's concept of *A. angustissima* var. *suffrutescens* (Rose) Isely, of southern and east-central Arizona and northern Sonora. Some plants show features of *A. angustissima* var. *shrevei* (Britton & Rose) Isely, of south-central Arizona and northern Sonora, but these two entities are doubtfully worthy of taxonomic separation. Benson and Darrow (1981) treat var. *suffrutescens* and var. *shrevei* as synonyms of *A. angustissima* var. *hirta* (Nuttall) B.L. Robinson, ranging from southern USA to Costa Rica.

This highly variable species includes a perplexing array of variation and more than two dozen named taxa that a number of botanists have attempted to sort with varying degrees of success. In temperate regions it is an herbaceous perennial, freezing to the ground in winter, but in the tropics it is often a tree with a well-formed trunk and weedy shrub forms are common. The noted botanists Lyman Benson (Benson & Darrow 1945, 1981), Duane Isely (1969, 1998), Rogers McVaugh (1987), and Ira Wiggins (1942) all complained about the morphological and taxonomic morass but yet defined infraspecific taxa for their own part of the world. Wiggins (1942: 233) summed up the situation: "One recognizes a difference in two entities, but tries in vain to describe it." It is hard to slice up a continuum. The taxonomic revision of the genus by Rico and Bachman (2006) likewise leaves an unresolved situation for the populations in northwestern Mexico and adjacent southwestern USA.

OP: N fork of Alamo Canyon, 2750 ft, rocky soil, on cliff, 7 Oct 1951, *Parker 7741*. Bull Pasture, 3300 ft, 9 Aug 1979, *Bowers 1793*. Alamo Canyon, north fork, 2296 ft, shrub to 1.5 m tall, leaves dark green, fruit pendulous, 17 Oct 1987, *Baker 7550* (ASU).

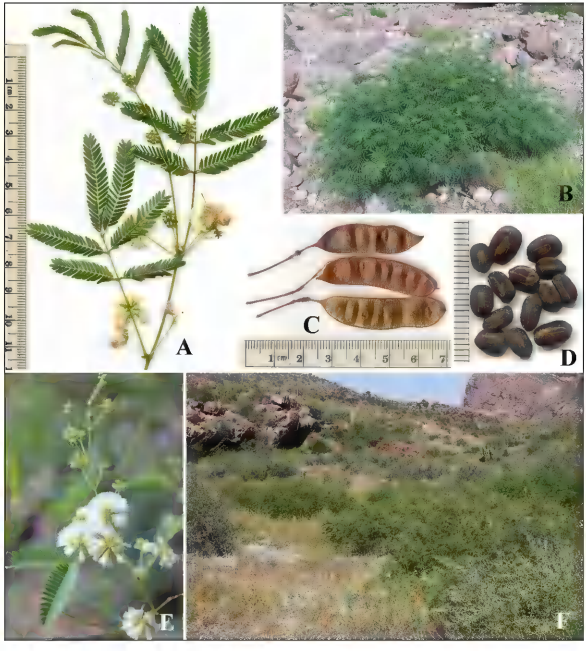

Figure 2. *Acaciella angustissima*. (A) South fork of Alamo Canyon, 3 Sep 2014. Alamo Well: (B) 7 Sep 2013; (E) 9 Sep 2013. Bull Pasture: (C & D) 19 Sep 2014; (F) 24 Sep 2006.

Acmispon – Deer vetch, trefoil

Annual or perennial herbs or subshrubs. Leaves odd-pinnate, the leaflets 3–7; stipules (those in the Sonoran Desert) represented by small but conspicuous, dark glands. Flowers papilionoid; yellow to red-orange, in small axillary umbels, the peduncle often with a leaf-like bract, or flowers solitary in leaf axils. Stamens 10; 9 filaments fused, 1 free. Pods elastically dehiscent, the valves coiling; seeds 2–12 (those in the flora area).

Western North America from Canada to Mexico, and South America; 23 species. A genus segregated from *Lotus*.

1. Perennials; stems firm and upright, the internodes notably longer than the leaves; peduncles much longer than the leaves; flowers 1.5–2 cm long..... **Acmispon rigidus**
1. Winter-spring annuals; stems not firm, ascending to prostrate, the internodes usually not longer than the leaves; flowers nearly sessile or on peduncles shorter to slightly longer than the leaves; flowers less than 1 cm long.

2. Plants markedly pubescent with long hairs; flowers sessile or nearly so, 1 per leaf axil. ..... **Acmispon brachycarpus**
2. Plants glabrous or pubescent but not densely long-haired; peduncles to slightly longer than the leaves, 1- to several-flowered.

3. Leaflets broadly elliptic or nearly so, widest at or slightly above middle, the tip rounded to pointed (acute) ..... **Acmispon maritimus**
3. Leaflets markedly obovate, broadest at or near the tip and gradually tapered to the base, the tip blunt (truncate) and sometimes notched ..... **Acmispon strigosus**

Acmispon brachycarpus (Bentham) D.D. Sokoloff
[*Hosackia brachycarpa* Bentham. *Lotus humistratus* Greene]
Hill lotus. Figure 3.

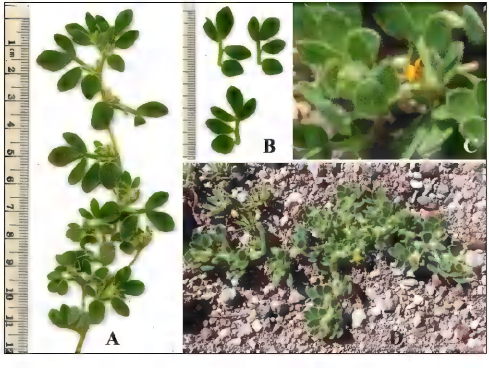

Figure 3. *Acmispon brachycarpus*. (A, B, & D) Kuakatch Wash near Kuakatch Village, 11 Mar 2015. (C) Coffeepot Mtn, 27 Feb 2005.

Spring annuals, mostly prostrate, densely hairy with rather long, soft, white to yellowish hairs. Leaves ± 1 cm long; the leafstalk flattened, the leaflets 3 or 5, 5–15 mm long, broadly elliptic to obovate. Flowers sessile or nearly so, ca. 5–7 mm long, yellow-gold, becoming reddish with age. Pods 6–12 mm long, with 2–5 seeds.

Widespread at least in the eastern half of Organ Pipe; on wide-ranging substrates such as desert pavement and sandy or gravelly sediments in wash beds, from lower bajadas to upper elevations.

Southwestern USA and adjacent Mexico.

OP. Near road 9 mi N of Sonoyta, 22 Mar 1941, *McDougall 14*. Dripping Springs, 25 Mar 1944, *Clark 11459* (ORPI). Alamo Canyon, 12 Apr 1978, *Bowers 1246* (ORPI). 1.4 mi N of Visitors Center on Hwy 85, 31 Mar 1979, *Bowers 1610*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-280*.

Acmispon maritimus (Nuttall) D.D. Sokoloff var. **brevivexillus** (Ottley) Brouillet
[*Lotus salsuginosus* Greene var. *brevivexillus* Ottley. *L. humilis* Greene. *Hosackia humilis* (Greene) Abrams]
Bird's-foot trefoil. Figure 4.

Spring annuals, mostly low-growing or prostrate. Herbage often semi-succulent, glabrous or sparsely pubescent. Leaves 1.5–2.8 cm long, the leafstalk moderately flattened, the leaflets 3–7 (lower leaflet often single rather than paired), thick, broadly elliptic, the tip broadly rounded to acute with a small, blunt point. Flowers 2–4 on slender peduncles with a leaflet-like bract on the joint (node) below the flowers. Flowers 5.5–7 mm long, the corollas bright yellow, or the banner becoming pale orange. Pods 10.5–16.5 mm long. Seeds 5–8 per pod, rounded, 1.3–1.4 mm wide, mottled, and smooth.

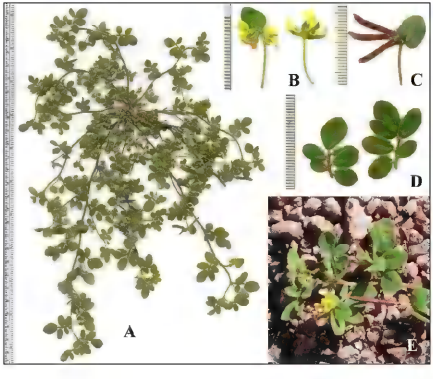

Figure 4. *Acmispon maritimus* var. *brevivexillus*. Kuakatch Wash near Hwy 85: (A) 24 Mar 2014; (B–D) La Abra Plain, South Puerto Blanco Drive, 25 Feb 2015. (E) Alamo Wash, 11 Mar 2014.

Widespread across the flora area; mostly along washes, also on bajadas and plains, and rocky slopes.

Baja California to southern California, Arizona, and northwestern Sonora.

OP: Headquarters Area, 10 Apr 1941, *McDougall 78*. Pozo Nuevo, 30 Mar 1978, *Bowers 1105*. 2.5 mi W of Hwy 85 on one-way Puerto Blanco Drive, 11 Apr 1978, *Bowers 1221*. Above Bull Pasture on trail to crestline, 3220 ft, 10 Apr 2005, *Felger 05-232*.

CP: 7 mi E of Papago Well, 22 Mar 1935, *Peebles 10863*. Tule Tank, 2 Feb 1992, *Felger 92-67*. San Cristobal Wash, 11 Apr 1992, *Harlan 157a* (CAB). Bassarisc Tank, 26 Feb 1993, *Felger 93-122A*.

Acmispon rigidus (Bentham) Brouillet
[*Hosackia rigida* Bentham. *Lotus rigidus* (Bentham) Greene]
Desert rock-pea. Figure 5.

Perennial subshrubs, often summer-dormant, 20–70 cm tall; strigose with appressed white hairs. Stems firm, brittle with age, with long internodes and sparsely leafy. Leaves and ultimately many twigs drought deciduous. Leaves sessile or the petioles very short (1–2 mm long), the leaflets 3–5, thick, linear-oblong, 10–15 mm long. Peduncles (3) 5–10 cm long, resembling the twigs, mostly 1-flowered, with a 1–3-foliolate bract below the flower. Flowers 1.5–2 cm long, the corolla uniformly bright yellow, soon developing a red-orange nectar guide, and with age the corollas becoming red-orange or pink. Pods slender, 1.8–4 cm long. Seeds 6–12 per pod, 1.5–2 mm wide, rounded or quadrangular. Flowering at least in early spring and sometimes with summer rains. Plants sometimes killed by low temperatures.

Figure 5. *Acmispon rigidus*. Estes Canyon: (A) 2 Mar 2008; (B & C) 16 Feb 2005.

Arroyos and canyons among boulders and rock slopes, often north-facing; to the summits in the granitic ranges in Tinajas Altas and eastward to the larger mountains in Organ Pipe. It has grown in the Tinajas Altas Mountains for 11,000 years.

Arizona, southern Nevada, southwestern Utah, southeastern California, both Baja California states, and northern Sonora. Isely (1998: 657) wrote, "This desert species is perhaps our ugliest *Lotus*." We disagree, it is a beautiful plant when in full flower and is commercially grown as an ornamental plant in southern Arizona (e.g., Mountain States Wholsale Nursery 2015).

OP: Pitahaya Canyon, *Nichol 23 Feb 1939* (ORPI). Ajo Mts, summit, 1 Apr 1944, *Clark 11527* (ORPI). W slopes of Montezuma's Head, 2600 ft, 16 Jan 1976, *Van Devender 76-1*. Canyon Diablo, 13 Feb 1978, *Bowers 1058*. Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-547*.

CP: Tule Tanks, 21 Mar 1933, *Shreve 6228*. Buckhorn Tank, 20 Mar 1987, *Elias 10281*. Vicinity of Heart Tank, 27 Feb 1993, *Felger 93-153*. Observations: Halfway Tank, 15 Jun 1992, *Felger*. Sierra Pinta, summit, 15 Nov 2003, *Cain*.

TA: Tinajas Altas, 5 Mar 1927, *Harrison 3610*. †Tinajas Altas, fruits, seeds, 4010 to 10,750 ybp (7 samples).

Acmispon strigosus (Nuttall) Brouillet
[*Hosackia strigosa* Nuttall. *Lotus strigosus* (Nuttall) Greene var. *tomentellus* (Greene) Isely. *L. tomentellus* Greene]
Hairy lotus. Figure 6.

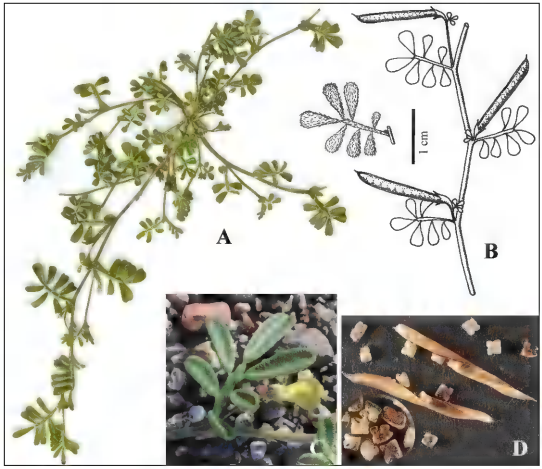

Figure 6. *Acmispon strigosus*. (A) Armenta Ranch, 13 Feb 2005. (B) By Matthew B. Johnson. (C) Alamo Wash near Alamo Bridge, 26 Feb 2014. (D) Sandy Flat Campground, Kern River, Kern Co., CA, photo by Jean Pawek, Rancho Santa Ana Botanic Garden Seed Program.

Winter-spring ephemerals; roots conspicuously nodulated. Stems spreading, becoming prostrate, 4–30+ cm long. Herbage sparsely to densely hairy (cinereous to strigose). Leaves 7–23 mm long, the leafstalk flattened, the petioles 4–7.5 mm long, the leaflets (3) 5–7, relatively thick,

keeled, obovate, 4.5–13 mm long, the tip truncate (blunt) and sometimes notched. Flowers solitary and sessile in axils, or 1 or 2 on slender peduncles with a leaflet-like or sometimes 3-foliolate bract on the joint (node) just below the flower(s). Flowers 7.5–9 mm long, the corollas bright yellow with a red nectar guideline on the banner. Pods 12–27 mm long. Seeds 8–11 per pod, 1.5–2.2 mm wide; of two kinds: nearly round, yellow-green, and minutely granulate, or somewhat kidney- or thickly U-shaped, mottled brown on buff, and smooth. Seed morphology seems constant for an individual plant and perhaps among local populations.

Widespread in many habitats including washes, flats, dunes, and desert pavements, and less common on rocky slopes.

Arizona below the Mogollon Rim to Nevada and California, Baja California, and northwestern Sonora.

OP: Tres Alamos Canyon, 2700 ft, *Nichol 24 Feb 1939*. Dripping Springs, 16 Apr 1952, *Parker 7939*. 2 mi WSW of Bates Well, 30 Mar 1978, *Bowers 1126*. Aguajita, 6 Apr 1988, *Felger 88-283*. Trail above Bull Pasture to the crestline, 3220 ft, 10 Apr 2005, *Felger 05-233*.

CP: Papago Well, 26 Mar 1932, *Shreve 5923*. Tule Tank, 2 Feb 1992, *Felger 92-68*. Bassarisc Tank, 26 Feb 1993, *Felger 93-124*. Pinta Sands, dunes, 11 Apr 1993, *Felger 93-428*. Chico Suni Hills, 2 Feb 2003, *Rutman 2003-32*.

TA: Tinajas Altas, *Van Devender 9 Mar 1980*. Tinajas Altas Canyon, 19 Mar 1998, *Felger* (observation).

†**Acmispon** sp./spp.

OP: †Puerto Blanco Mts, fruit fragments, seeds, modern (30) to 14,100 ybp (7 samples).

Astragalus – Milkvetch, locoweed

Winter-spring annuals in the flora area (elsewhere many are perennial herbs) with a well-developed taproot. Leaves odd-pinnate. Inflorescences of axillary racemes or spikes. Flowers papilionoid. Calyx 5-toothed. Stamens 10; 9 filaments fused, 1 free. Pods variable, inflated or not, sessile or the base variously elongated into a stipe or stipe-like stalk. Seeds 2 to many per pod.

This is the largest genus of flowering plants, with over 2500 species worldwide.

1. Racemes 2–18+ cm long (flower-bearing portion, does not include the peduncle), the flowers not crowded, each 7–20 mm long; pods inflated.

2. Racemes 2–4 cm long; flowers 7–8 mm long; pods conspicuously inflated, one-celled; dunes of Pinta Sands, Cabeza Prieta ..... **Astragalus insularis**
2. Racemes often 10–18 cm long; flowers ±10 mm long; pods moderately inflated, 2-celled with a well-formed septum; east side of Organ Pipe..... **Astragalus lentiginosus**

1. Racemes 2 cm or less in length, the flowers crowded, each 3–6 mm long; pods not inflated.

3. Racemes many-flowered; pods 4–5 mm long, rounded or ovoid, not curved, 2-seeded.
..... **Astragalus didymocarpus**
3. Racemes 1–3-flowered; pods 12–20 mm long, curved at maturity, multiple-seeded.
..... **Astragalus nuttallianus**

Astragalus didymocarpus Hooker & Arnott var. **dispermus** (A. Gray) Jepson
[*A. dispermus* A. Gray]
Dwarf white milkvetch. Figure 7.

Herbage bluish green, with short white hairs. Stems very slender, spreading or sprawling, not erect. Leaves 2–5 cm long; leaflets 9–17, oblong to oblanceolate or obovate, 3–10 mm long. Flowers crowded into small, head-like rounded or ovate clusters on long, slender peduncles; flowers 5–6 mm long, pink-purple with white on tips of wing petals. Pods 4–5 mm long, firm and wrinkled, with a septum forming 2 chambers, each with a single seed.

Figure 7. *Astragalus didymocarpus* var. *dispermus*. (A & C) Armenta Ranch, 13 Feb 2005. (B & D) Coffeepot Mountain, Maricopa Co., 27 Feb 2005.

Ajo Mountains, especially common and widespread above Bull Pasture, and elsewhere near the north end of the mountains and the northern margin of the monument. Often growing with *A. nuttallianus*.

Variety *dispermus* occurs in southeastern California, eastern Baja California, southern and western Arizona, and expected in Sonora east of Sonoyta. This species, with four varieties, ranges to northern California and Pacific Baja California.

OP: *Larrea-Ambrosia* flat in valley N of Montezuma's Head, *Rutman 4 Apr 1998* (ORPI). Armenta Road 1.4 mi W of Hwy 85, 11 Mar 2003, *Felger 03-260*. Above Bull Pasture, trail to crestline, 3220 ft, 10 Apr 2005, *Felger 05-226* (ARIZ, ASU).

Astragalus insularis Kellogg var. **harwoodii** Munz & McBurney
Sand locoweed; *kopondakud*. Figure 8.

Stems erect to sprawling. Herbage green to silvery (strigulose), the pubescence mostly of hairs much less than 0.5–0.6 mm long, firm, white, and mostly appressed. Leaves (3) 4–11 cm long; leaflets 13–19 in number, 6–12 (20) mm long. Racemes 2–4 cm long; flowers not crowded, (5) 8–9 (10) in number, 7–8 mm long. Corollas violet when fresh and dry, the banner petal with dark spots and a white eye between lavender veins. Pods (16) 20–24 mm long, papery-membranous, greatly swollen (inflated), and purple flecked with minute, coarse hairs; with 8 or more seeds.

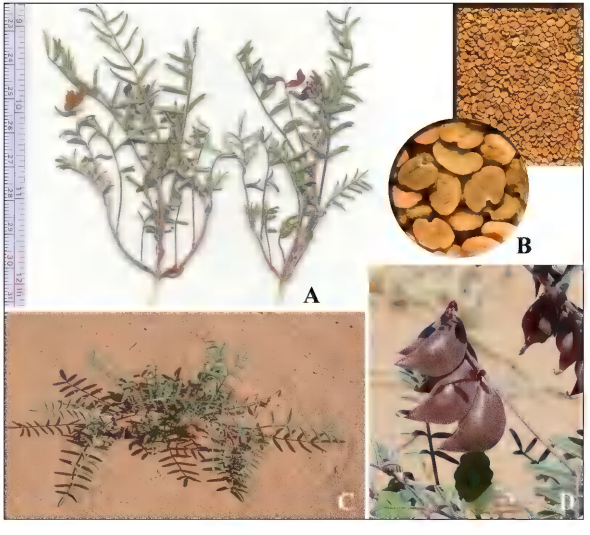

Figure 8. *Astragalus insularis* var. *harwoodii*. (A) Pinta Sands, 11 Feb 2014. (B) Photo by John MacDonald, Rancho Santa Ana Botanic Garden Seed Program. (C) Dunes 22 mi SW of Sonoyta on Mex Hwy 8, Sonora, 27 Mar 2010. (D) Gran Desierto near Mex Hwy 2, Pinacate Biosphere Reserve, Sonora, 5 Mar 2014.

Sand flats and dunes in the vicinity of the Pinta Sands and Pinacate Lava.

This variety occurs in southwestern Arizona, southeastern California, northeastern Baja California, and northwestern Sonora. This species, with three varieties, ranges to Baja California Sur.

CP: Pinta Sands, *Monson 21 Feb 1958* (CAB). Pinta Sands, 1.3 mi N of Mexico, 780 ft, sandy *Larrea* desert, 10 Apr 1978, *Reeves 6798* (ASU, det. R. Barneby 1978). Pinta Sands E of Pinacate Lava Flow, sand dunes, 21 Mar 1979, *Yatskievych 79-243*. Dunes, 6 mi W of O'Neill's Grave, 31 Mar 1983, *Eiber 33*.

Astragalus lentiginosus Douglas ex Hooker var. **australis** Barneby
Freckled milkvetch. Figure 9.

Figure 9. *Astragalus lentiginosus* var. *australis*. Vicinity of E boundary of Organ Pipe, near Kuakatch Village, 24 Mar 2013.

Plants fairly robust, the herbage glabrate or with curved or spreading hairs. Larger leaves 10 or more cm long; leaflets mostly 9–21, obovate to elliptic. Racemes elongate, open, the flowers not crowded. Flowers ±1 cm long; pale pink-purple, becoming bluish with age, the banner with a white spot at the base (white between pink-purple veins). Pods ±1.5–2 cm long, greenish and speckled with red when fresh, moderately firm and inflated, nearly rounded in cross section, curved upward and held upright, with coarse white and somewhat silky hairs; incompletely 2-chambered, the septum readily visible, dividing ¾ of the pod. Seeds probably 10–20.

Known from the east side of Organ Pipe by a few specimens. These are likely waifs from nearby areas to the east of Organ Pipe, where this milkvetch is fairly common. Plants from Organ

Pipe and adjacent areas are spring annuals, although elsewhere this variety is known as a short-lived perennial.

Southern Arizona eastward from Organ Pipe to west Texas and adjacent northern Mexico.

Barneby (1964) distinguished an amazing diversity of 36 geographic varieties of this species, and Isely (1998) expanded the complex to 40 varieties; western USA and northern Mexico.

OP: Alamo Canyon, 2000 ft, *Tinkham 18 Apr 1942* (det. Duane Isely, no date). Wash, 1798 ft, *Walden 19 Apr 1964* (ASU, det. R. Barneby 1970). Victoria mine site 1.5 mi W of campground, 1650 ft, *Kurmes 13 Mar 1989* (ASC).

Astragalus nuttallianus de Candolle cf. var. **imperfectus** (Rydberg) Barneby
[*Hamosa imperfecta* Rydber]
Small-flowered milkvetch. Figure 10.

Plants often diminutive, the stems very slender; hairs appressed, white and firm. Leaves often 2–5.5 (7) cm long; leaflets 7–11 (13), elliptic to linear-elliptic, 3.7–17.6 mm long, the tips pointed (acute to obtuse). Racemes on very slender peduncles 2.5–5 (8) cm long, 1–3-flowered: flowers close together, each 5–6 mm long, semi-cleistogamous (only partially opening and selfing), the petals lavender-pink. Pods 12–20 mm long, multiple-seeded, slender and strongly curved at maturity, not inflated and gradually or partially dehiscent. Seeds mostly 12–16 per pod.

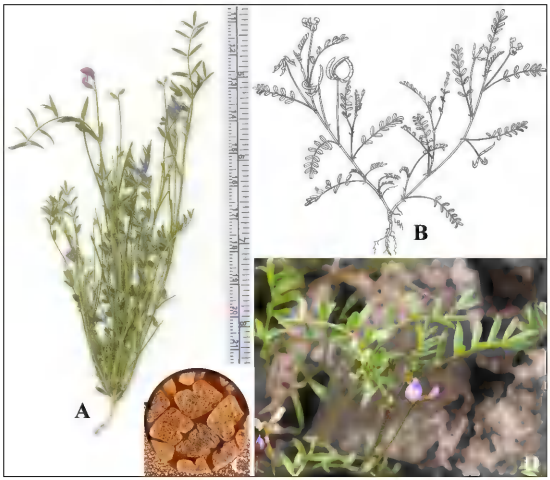

Figure 10. *Astragalus nuttallianus*. (A) Kuakatch Wash near Hwy 85, 2 Mar 2008. (B) By Lucretia Breazeale Hamilton. (C) *A. nuttallianus* var. *imperfectus*, photo by John MacDonald, Rancho Santa Ana Botanic Garden Seed Program. (D) Chuckwalla Hills, 27 Feb 2005.

In many habitats across most of the flora area; sandy, gravelly, and rocky soils, especially along washes, canyons, and floodplains, also on bajadas, plains, slopes, and mountains. This is the most common and widespread *Astragalus* in the region and the only one that occurs in both Cabeza Prieta and Organ Pipe. A member of this species complex was present in the Ajo Mountains 9600 years ago.

Astragalus nuttallianus occupies southwestern USA and the northern half of Mexico.

Barneby (1964) recognized 10 varieties. Most of the specimens from the flora area resemble var. *imperfectus*, which occurs in western Arizona, southeastern California, Nevada, northwestern Arizona, and northeastern Baja California. This variety is distinguished in part by its relatively short calyx lobes (to ca. 1.5 mm long) and short hairs (0.8 mm long or less). Two other varieties have been cited for the region: var. *austrinus* (Small) Barneby, which mostly ranges eastward, and var. *cedrosensis* M.E. Jones, which mostly ranges westward. Specimens from the general flora area identified or annotated by Barneby (1964) and also by Isely (1998) do not necessarily match key features for the varieties given in their publications.

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939*. Boulder Canyon, 10 Mar 1973, *Shervanick 723* (RSA). N end Bates Mts, 23 Feb 2003, *Rutman 2003-180* (ORPI). 0.5 mi W of Growler Pass, 8 Mar 2003, *Rutman 2003-273* (ORPI). 0.1 mile E of OP western boundary, San Cristobal Valley, 20 Mar 2003, *Rutman 2003-369* (keys to var. *cedrocensis*). Above Bull Pasture, trail to crestline, 3220 ft, 10 Apr 2005, *Felger 05-227*. †Variety not known: Alamo Canyon, fruits, seeds, 9570 ybp.

CP: Agua Dulce Mts, *Elias 19 Mar 1987* (RSA). NE of Davis Hills, *Elias 20 Mar 1987* (RSA). Tule Mts, 12 Apr 1992, *Harlan 245* (CAB). Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-270*.

†Astragalus sp.

OP: Montezuma's Head, seeds, 21,840 ybp.

Calliandra

Herbaceous perennials, shrubs, and trees. Flowers mimosoid. Southwestern USA to South America; 130 species.

Calliandra eriophylla Bentham

Fairy duster; *huajillo*. Figure 11.

Unarmed woody shrubs often 0.5–0.8 (1) m tall, with firm but flexible stems and grayish bark; especially the young growth moderately to densely pubescent with short white hairs. Leaves twice pinnate, without leafstalk glands, gradually drought deciduous and frost sensitive, the pinnae (1) 2–4 pairs; leaflets 2.5–6 mm long, 6–15 pairs per pinna. Long-shoot leaves may be much larger than short-shoot leaves. Flowering mostly in February and March and also with summer rains; inflorescences axillary; flowers clustered in pedunculate heads. Flowers sessile, the stamens showy and numerous, united below, 1.5–2 cm long, whitish to pinkish, opening at night, drooping with daytime heat; anthers small, the pollen shed in 8-grained polyads. Pods often 4–7.5 cm long, flattened with thick cord-like margins, the valves separating elastically and curling back but not twisting.

Widespread in Organ Pipe, mostly along washes and rocky slopes of hills and mountains, and in the eastern portion of Cabeza Prieta mostly on north-facing slopes and arroyo banks.

Southeastern California to Texas and southward to Chiapas and Baja California.

OP: Quitobaquito, *Nichol 3 Mar 1939* (ORPI). Ajo Mt Drive, Mar 1976, *McCarten 2058*. Puerto Blanco Drive, 13 mi NW Visitor Center, 11 Feb 1978, *Bowers 1048*. Walls Well Road, *Van Devender 30 Aug 1978*. Bull Pasture, 1500 ft, *Mittleman 10 Mar 1981* (DES).

Figure 11. *Calliandra eriophylla*. (A) Little Ajo Mts, 24 Feb 2008. (B) Ajo, 18 Mar 2005. (C) Victoria Mine, 1 Apr 2010. (D) By Lucretia Breazeale Hamilton.

CP: Charlie Bell Road at E boundary of Refuge, 25 Feb 1993, *Felger 93-48*.

Chamaecrista – Partridge-pea

Annuals, herbaceous perennials, shrubs, and trees. Flowers caesalpinioid. Mostly New World; 270 species. A genus segregated from *Cassia*.

Chamaecrista nictitans (Linnaeus) Moench var. **mensalis** (Greenman) H.S. Irwin & Barneby
[*Cassia leptadenia* Greenman var. *mensalis* Greenman. *Chamaecrista leptadenia* (Greenman) Cockerell]
Sensitive partridge pea. Figure 12.

Delicate summer annuals with a single main axis, often 10–30+ cm tall. Herbage pubescent, the leaflets ciliate. Leaves once-pinnate, (2) 3–4.5+ cm long, with a prominent, raised petiole gland, and 7–15 pairs of leaflets. Flowers in leaf axils, bright yellow, ± 5 mm long. Stamens variable in this species, with 5–10 functional stamens; anthers opening by terminal pores. Pods 3.5–4+ cm long,

elastically dehiscent, with (5) 8–12 seeds. Seeds ± quadrangular, 2 mm wide, dotted with raised glands.

Figure 12. *Chamaecrista nictitans* var. *mensalis*. Bull Pasture, 19 Sep 2014.

Known from the flora area by a single collection from the Ajo Mountains, where it was common along an ephemeral stream.

Irwin and Barneby (1982) recognized 12 subspecies and varieties of this annual species, ranging from the USA to Argentina. Variety *mensalis* ranges from the southwestern USA to Michoacán and also occurs in Baja California Sur.

OP: Bull Pasture, along ephemeral stream, 19 Sep 2014, *Rutman 20140919-5*.

Coursetia

Herbaceous perennials, shrubs, and trees. Flowers papilionoid. Southwest USA to Argentina and the Caribbean; 40 species.

Coursetia glandulosa A. Gray
[*C. microphylla* A. Gray]
Sámota. Figure 13.

Figure 13. *Coursetia glandulosa.* (A) Estes Canyon Trail, 25 Sep 2013. (B) Alamo Canyon, 4 Mar 2006. (C–D) Ajo, 17 Mar 2015. (E) Senita Basin, 15 Mar 2015. (F) Arch Canyon, 2 Aug 2013.

Unarmed shrubs to 2.5 m tall with multiple and slender, flexible, hardwood stems. Leaves often 2–6 cm long (highly variable, reaching ca. 12 cm when well watered, especially with summer-fall rains), even-pinnate mostly with 8–18 leaflets, the leaflet midrib extends into a short bristle-tip (apiculate); foliage unfolding after flowering if there is sufficient soil moisture; leaves luxuriant with large, thin leaflets during the summer-fall rainy season and gradually drought deciduous during fall and winter. Inflorescence branches, peduncles, calyx, and pods glandular pubescent. Flowers 10–12 mm long, the petals pale yellow and white with faint red tinges, flowering mostly in March and April, often when the plants are leafless or nearly so. Stamens 10; 9 filaments fused, 1 free. Pods to 6+ cm long, slender, glandular-sticky, multiple-seeded, with a septum and constriction between each seed, and explosively dehiscent, the valves coiling.

Widespread in the less arid areas in Organ Pipe; canyons and on rocky slopes, especially north- and east-facing. The most arid locality for this shrub is in the Bates Mountains. It was in the Ajo Mountains 1200 years ago.

Southern Arizona and southwestern Chihuahua to Oaxaca and Baja California Sur.

The stems are sometimes encrusted with orange-colored lac produced by the ant-tended scale insect *Tachardiella fulgens* (Kondo & Gullan 2011). In southern Arizona and western Sonora we know of this orange lac only occurring on *Coursetia glandulosa*, although the occurrence tends to be highly localized. This lac, plastic when heated, was used by Native Americans as a sealant and adhesive (Felger 2007a; Felger & Moser 1985; Felger & Wilder 2012). *Sesbania* is erroneous reported as a possible host plant (e.g., Kondo & Gullan 2011). The error can be traced to Cockerell (1895: 1–2), who wrote, "*Hab.* Arizona, received from Prof. J.W. Toumey [University of Arizona, Tucson] . . . . has seen only the stem of the food-plant, but thinks it is a *Sesbania*" (Kondo & Gullan 2011: 357). *Sesbania* is an annual in the Sonoran Desert region and is not known to be a host plant for *Tachardiella*. Similar and far more common and more widely utilized lac from *T. larrea* occurs on creosotebush (*Larrea*) (e.g., Felger 2007a; Stacey et al. 1998).

OP: Alamo Canyon, *Nichol 4 May 1939*. Senita Pass, 13 Apr 1941, *McDougall 86*. Dripping Springs, 15 Apr 1952, *Parker 7919*. N end Puerto Blanco Mts, 14 Mar 2003, *Rutman 2003-308* (ORPI). Canyon NW of Kino Peak, 2000 ft, 20 Mar 2005, *Rutman 2005-0320-35* (ORPI). †Alamo Canyon, twigs, leaflets, 1150 ybp.

Dalea

Annual or perennial herbs and shrubs. Herbage and flowers dotted with blister-like glands (secretory vesicles with aromatic oils). Leaves odd-pinnate (leaflets lacking the small wavy lines seen in *Marina*). Flowers papilionoid, subtended by a bract and usually 2 bractlets. Calyx tube 10-ribbed with rows of glands between the ribs, and 5 ribs extending into lobes, teeth and/or awns longer than the tube (those in the flora area). Stamens 9 or 10 (those in the flora area), the filaments united below (basally) into a tube. Pods indehiscent, small and 1-seeded (two ovules in each ovary but only one matures into a seed). New World; 165 species.

1. Annuals; stems and leaves pubescent; widespread and common…… **Dalea mollis**
1. Perennials; stems and leaves glabrous or glabrate; Ajo Mountains and not common.

2. Leaflets 5–7 per leaf; floral bracts (subtending each flower) glabrous…… **Dalea pogonathera**
2. Leaflets 13–29; floral bracts hairy…….... **Dalea pringlei**

Dalea mollis Bentham
Silky dalea. Figure 14.

Non-seasonal annuals, mostly found during spring and sometimes living through the summer; highly variable in size depending on soil moisture; with a relatively deep, yellow-orange taproot and nodulated secondary roots. Herbage with slender, spreading, white hairs and dotted with swollen, maroon glands. Stems 10–30+ cm long, erect to prostrate with age. Leaves 1.5–2.7 (3) cm long; leaflets (7 or 9) 11 or 13, often glaucous, mostly cuneate to obovate or obcordate, 4–7 mm long, the tip often truncate or notched, the lower surfaces gland-dotted, the upper surfaces glandless, the margins entire and flat. Racemes (1) 1.5–3.5 cm long, densely flowered and appearing furry due to densely crowded, long, whitish to tawny, and tightly spiraled silky hairs on the calyx tube and teeth, the hairs often obscuring the flowers and fruits. Inflorescences and pedicels with conspicuous teardrop-shaped, dark maroon-brown glands remaining after the flowers or fruits have fallen. Flowering at a very early age and continuing as long as soil moisture is available. Floral bracts 0.7–1 mm wide, often extending into an awn-like bristle. Pedicels very short and persistent. Calyx tube 1.8–2.4 mm long (measured from pedicel to sinus between calyx teeth), with rows of small iridescent orange glands, the margins and midribs dark maroon, the teeth triangular, the midribs extending into stout, densely long-haired bristles (awns). Corollas (3.5) 4.5–6.5 mm long, scarcely longer than the calyx teeth/bristles. Wing petals notched with a gland, or the notch and gland sometimes absent. Upper, or exposed, portion of petals violet, drying red-purple. Pods 2.5 mm long, obovoid.

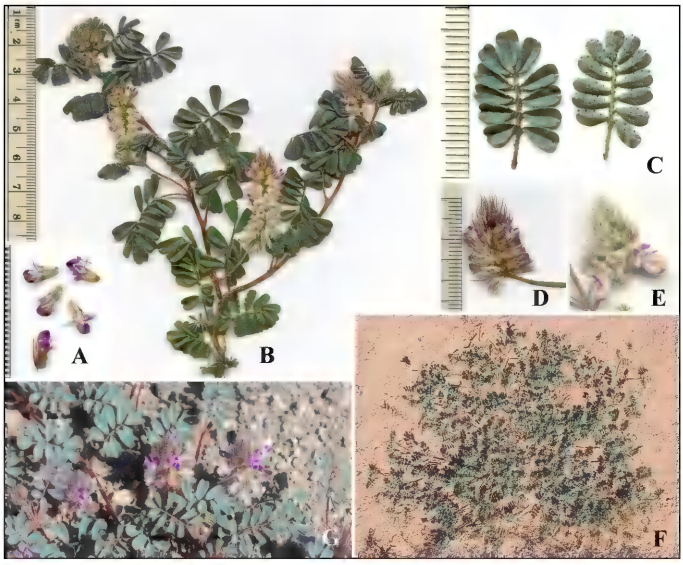

Figure 14. *Dalea mollis*. (A & D) Knucklehead Wash, south of Childs Mtn, 3 Mar 2015. (B) Charlie Bell Road, southern foothills of Childs Mtn, 5 Sep 2014. (C) Ajo, 23 Mar 2015. (E & F) Gran Desierto, 5 Mar 2014. (G) Acuna Valley, 12 Mar 2015.

One of the most common and widespread ephemeral legumes in the region. Found on a wide variety of substrates, disturbed and undisturbed, from low to high elevations, including washes, sandy plains, dunes, and slopes. Plants on dunes are lighter-colored than those off the dunes. Its history in the flora area extends to 6000 years.

Sonoran Desert in Arizona, California, Baja California, Baja California Sur, and Sonora.

OP: 8 mi S of Growler Well, Bates Mts, *Nichol 17 Apr 1939*. Growler Mts, foothills, 16 Apr 1952, *Parker 7976*. Cipriano Pass, 30 Mar 1978, *Bowers 1115*. E end of Quitobaquito Hills, *Warren 10 Nov 1983*. Alamo Canyon, 17 Oct 2013, *Rutman 20131017-5*. Trail above Bull Pasture, 4090 ft, 15 m below crestline, 10 Apr 2005, *Felger 05-286*.

CP: 1 mi E of Papago Well along Camino del Diablo, 13 Mar 1983, *Eiber 19*. NE edge of Las Playas, 15 Apr 1964, *Niles 363*. Pinta Sands, 15 Sep 1992, *Felger 92-779*. Tule Desert, 2 mi NW of Christmas Pass, *Rutman 18 February 2002*.

TA: E margin of Davis Plain at base of Gila Mountain, W branch of Camino del Diablo, 965 ft, in rock crevices and nearby on sandy soil, *Felger 05-67*. †Tinajas Altas, fruits, 5860 & 5940 ybp.

Dalea mollis is one of five species comprising sect. *Theodora* of subg. *Theodora*, occurring in Mexico and southwestern USA (Barneby 1977). *Dalea mollis*, *D. mollissima*, and *D. neomexicana* form a complex of similar appearing but distinctive species. Some confusion is due to the many misidentified specimens in herbaria. Barneby's extraordinarily detailed descriptions, information, and insight are worthy of review and continued investigation.

Dalea mollis is replaced by *D. mollissima* in the hotter and drier, lower elevations of the western and northwestern reaches of the Sonoran Desert mostly in southwestern USA and into the Mohave Desert. However, their geographic ranges overlap and the two species often occur together with no indication of intermediates or hybrids. "Probably the small, dull-hued flowers are autogamous, which would permit two closely related species to mingle without loosing their identity" (Barneby 1977: 162). *Dalea mollis* is replaced to the east, from Arizona to Texas and southward into the Chihuahuan Desert Region in Mexico, by *D. neomexicana* A. Gray. They are apparently allopatric. In Arizona *D. neomexicana* generally occurs at elevations above the Sonoran Desert.

Dalea mollissima (Rydberg) Munz
[*Parosela mollissima* Rydberg]

Non-seasonal ephemerals; resembling *Dalea mollis* but generally more robust and larger in all dimensions, the leaflets notably more glaucous and their margins undulate (wavy). Leaflets (9) 11–15 per leaf, mostly 5–8+ mm long. Floral bracts greenish, lanceolate, 0.8–1.6 mm wide. Calyx tube 2.5–3 mm long, the bristles (awns) 2.6–4.5+ mm long. Keel petals about as long as the calyx, thus hardly showing; wing petals entire, glandless.

Sandy plains with *Larrea* and *Ambrosia dumosa* in the extreme northwestern corner of the Gran Desierto in Sonora, closely approaching the southwestern part of the flora area in Cabeza Prieta and the Tinajas Altas Region. *Dalea mollissima* also occurs in Arizona near the western and northwestern limits of the flora area, as well as other dry regions of western Arizona, southern Nevada, northeastern Baja California, and southeastern California. They can be distinguished as follows:

1. Leaflet margins entire and flat; floral bracts 0.7–1 mm wide; calyx tube 1.8–2.4 mm long, the calyx teeth (bristles) 1.1–3.1 mm long; wing petals often notched and with a gland…….. **Dalea mollis**
1. Leaflet margins undulate (wavy); floral bracts 0.8–1.6 mm wide; calyx tube 2.5–3 mm long, the calyx teeth (bristles) 2.6–4.5+ mm long; wing petals entire, glandless…….. **Dalea mollissima**

Dalea pogonathera A. Gray var. **pogonathera**
Bearded prairie-clover. Figure 15.

Herbaceous perennials, often with slender stems from a thick, knotty rootstock; herbage and inflorescences gland-dotted; herbage glabrous. Leaves often to 2 cm long; leaflets mostly 5 or 7, linear to narrowly elliptic, less than 1 cm long. Flowers to 10 mm long, crowded on spikes often 3–10 cm long; calyces densely hairy with long, silky, brownish hairs; corollas purple; anthers bright orange and conspicuous. Flowering non-seasonally following rains. Pods 4 mm long, and with silky hairs.

Figure 15. *Dalea pogonathera* var. *pogonathera*. (A) Salero Ranch, Santa Cruz Co., 8 Aug 2013, photo by Sue Carnahan. (B & C) Portal-Paradise Road, Chiricahua Mts, Cochise Co., 2 Jul 2006, photos by Patrick Alexander (SEINet).

Scattered records from the Ajo Mountains to the west-central part of Organ Pipe where it is a western outlier from the main population. The nearest recorded population is in the Baboquivari Mountains.

Arizona to western Texas, and northern Sonora to Coahuila and Zacatecas. Another variety occurs eastward in Texas and northeastern Mexico.

OP: Near Dripping Springs, Puerto Blanco Mts, 2000 ft, gravelly soil along wash on desert plain, foothill palo verde association, 16 Apr 1952, *Parker 7922*. 50 Mile Drive near Quitobaquito, 26 Mar 1965, *Ranzoni 338* (ORPI). Estes Canyon, *Hesselberg 10 Apr 1966* (ASU). 2-way Puerto Blanco Drive, 10 mi W of Hwy 85, 11 Apr 1978, *Bowers 1223* (ORPI; essentially the same place as *Parker 7922*).

Dalea pringlei A. Gray var. **pringlei**
[*Thornbera pringlei* (A. Gray) Rydberg]
Pringle's prairie-clover. Figure 16.

Herbaceous perennials and also flowering in the first season or year, erect growing, 0.5–2 m tall, the stems generally straight, glabrous or sparsely pubescent near the inflorescences. Herbage, calyces, and pods gland-dotted. Foliage sparse; leaves glabrous, often 1.5–5 cm long with 13–29

leaflets. Floral bracts densely hairy. Flowers crowded in terminal spikes 2–9 cm long appearing furry with silky haired (silky pilose) calyces. Corollas purple; anthers yellow. Flowering in spring and with summer rains. Pods 2.5–3 mm long.

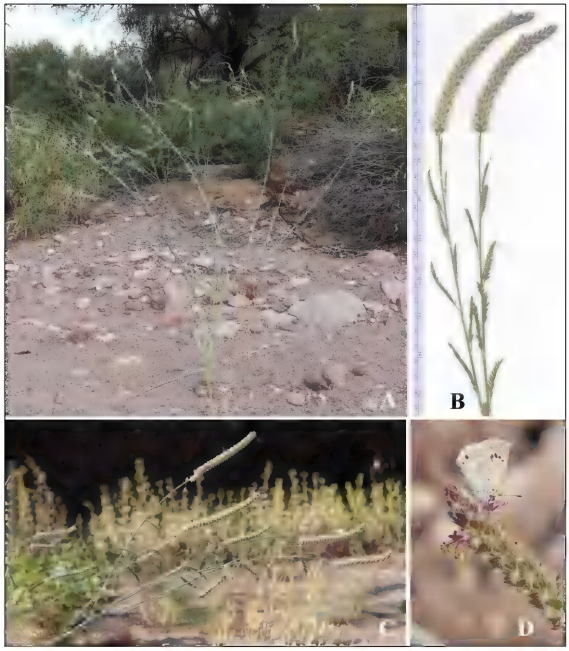

Figure 16. *Dalea pringlei* var. *pringlei*. Alamo Canyon: (A) 5 Nov 2013; (B–D) 20 Oct 2013.

Higher elevations in the Ajo Mountains, often on nearly barren rock, and Alamo Wash from the canyon area to below the Hwy 85 bridge.

Variety *pringlei* occurs eastward in southern Arizona and in northern Sonora. Two other varieties occur in southern Sonora, Sinaloa, and southwestern Chihuahua.

OP: Near top Mt Ajo, *Dakan 25 Jan 1973* (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-286*. Alamo Canyon, ⅓ mi upstream from Alamo Campground, 17 Oct 2013, *Rutman 20131017-5*.

Desmodium

Annuals, herbaceous perennials, shrubs, and a few trees. Flowers papilionoid; pods irregularly shaped. Nearly worldwide; 275 species.

Desmodium procumbens (Miller) Hitchcock

[*Hedysarum procumbens* Miller. *Desmodium procumbens* var. *exiguum* (A. Gray) B.G. Schubert. *D. procumbens* var. *transversum* (B.L. Robinson & Greenman) B.G. Schubert. *D. wigginsii* Schubert]

Western tick-clover. Figure 17.

Delicate summer annuals, often beneath trees and shrubs; usually short-lived and with very slender stems. Leaflets rough and dry to the touch due to minute hooked hairs. Leaves polymorphic, the earliest (lower) leaves with a single and broad leaflet, mid-stem leaves with 3 leaflets, the upper leaves with 1–3 narrow leaflets. Corollas pink, keel plus banner ca. 3–4 mm long; banner with a basal yellow-green "eyespot." Stamens 10, 9 united, 1 free. Pods unique, slender with minute hooked hairs, and often twisted or curled and resembling a string of cut-outs with 1-seeded triangular to somewhat square segments, and breaking apart between the segments. Reproductive August and September.

Figure 17. *Desmodium procumbens*. Bull Pasture Trail, 8 Sep 2014.

Ajo and Diablo mountains, mostly above 850 m; among rocks, along washes, and beneath trees and shrubs.

Eastward and northward in southern and central Arizona to New Mexico, Mexico to South America, the West Indies, and adventive in the Old World. If varieties are recognized, Arizona populations are var. *exiguum*. The varieties as well as species boundaries are poorly understood. *D. procumbens* is closely related to and perhaps not distinct from *D. neomexicanum* A. Gray, ranging from southeastern Arizona to Texas and South America.

OP: Bull Pasture, under shrubs, 20 Oct 1978, *Bowers 1549* (ORPI). Ajo Mts, saddle between Arch & Boulder Canyons, also common along the trail up N-slope to the saddle, 16 Sep 2006, *Rutman 2006-0916-2*. Diablo Mts, 2647 ft, shaded base of N-facing cliff, coarse colluvium, 22 Sep 2013, *Rutman 20130922-26*.

Galactia

Perennial herbs and vines. Flowers papilionoid. Nearly worldwide; 60 species.

Galactia wrightii A. Gray
Figure 18.

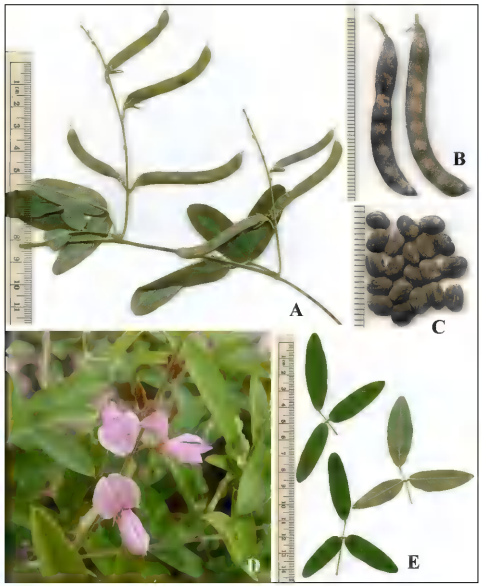

Figure 18. *Galactia wrightii*. Bull Pasture Trail: (A & E) 8 Sep 2014; (B & C) 19 Sep 2014. (D) Salero Ranch, Santa Cruz Co., 1 Aug 2013, photo by Sue Carnahan.

Herbaceous perennial vines from tough rootstocks. Leaves pinnately 3 foliolate, the leaflets usually oblong, variable with seasonal conditions; stipules small and deciduous. Inflorescences of several- to many-flowered racemes. Flowering at least August to October. Calyx 4-lobed, resulting from fusing of the upper 2 lobes, the lobes longer than the tube. Banner petal whitish with pink lines (nectar guides), other petals pale purple and pink. Stamens 10; 9 fused, 1 free. Pods slender, 5–6 cm long, straight to moderately curved, dehiscent with twisting valves. Seeds often 8–10 per pod, mottled black and brown.

Ajo Mountains above 850 m, often growing with *Quercus* and *Vauquelinia*.

Central Arizona to western Texas southward at least to Chihuahua and Sinaloa.

OP: Bull Pasture Trail, ca. 2800 ft, 20 Oct 1978, *Bowers 1543*. Arch Canyon, beneath arch, *Rutman 26 Sep 2002* (ORPI). Trail below Bull Pasture, NE-facing slope against wall of bedrock, common on mid-elevation and higher elevations of Ajo Mts, 22 Oct 2006, *Rutman 20061022-16*.

Hoffmannseggia

Unarmed perennial herbs and shrubs, generally with stalked glands. Leaves twice pinnate, the pinnae odd-pinnate; stipules small. Flowers caesalpinioid, in terminal racemes or panicles. Flowers yellow, the petals often red-flecked. Stamens 10, separate. Pods flattened, tardily dehiscent or indehiscent.

Southern USA and Mexico, and South America; 21 species.

1. Herbaceous perennials with seasonal stems less than 30 cm tall..... **Hoffmannseggia glauca**
1. Shrubs with perennial stems to about 1 m tall..... **Hoffmannseggia microphylla**

Hoffmannseggia glauca (Ortega) Eifert
[*Larrea glauca* Ortega. *Caesalpinia glauca* (Ortega) Kuntze]
Hog potato; *camote de ratón*; ʼi:kovi. Figure 19.

Herbaceous perennials from deep rhizomes and edible, small, potato-like tuberous roots; herbage with stalked, reddish glands and short, white hairs. Stems renewed annually or seasonally, usually several, ca. 15–20+ cm tall including the terminal inflorescence. Leaves several near the stem base, twice pinnate, 6–12 cm long, long petioled, with (7) 9 or 11 pinnae, the terminal pinna longest and with as many as 11 leaflet pairs, the other pinnae with 4–9 leaflet pairs; leaflets oblong, 2.8–5.5 (7) mm long. Inflorescences, flowers including sepals, petals, and filaments, and pods dotted with stalked glands, these sometimes red. Flowers in terminal racemes, the petals predominantly yellow-gold, the upper, keeled petal spotted red, stamens 10, separate, often red, and shorter than the petals. Pods 2.5–3 cm long, compressed, glandular, indehiscent to tardily dehiscent, and readily deciduous; several-seeded. Flowering during warm weather.

Locally abundant in clay soils of the large internally draining playas in Cabeza Prieta.

Southeastern California to Kansas and southward to both states of Baja California and northern Sonora to San Luis Potosí; also Peru, Chile, and Argentina.

The tuberous "potato-like" roots, or "wild potatoes," were cooked and eaten by the Cocopahs, Quechans (Yumas), Gila River Pimas, and others (Castetter & Bell 1951; Chittenden 1901; Forde 1931; Gifford 1933). The Gila River Pimas sometimes got the tuberous roots from a ground squirrel's cache during plowing (Rea 1997).

CP: Pinta Playa, *Phelps 9 Oct 1977*. Las Playas: 11 Apr 1978, *Reeves 6806*; 28 Nov 2001, *Felger 01-556*.

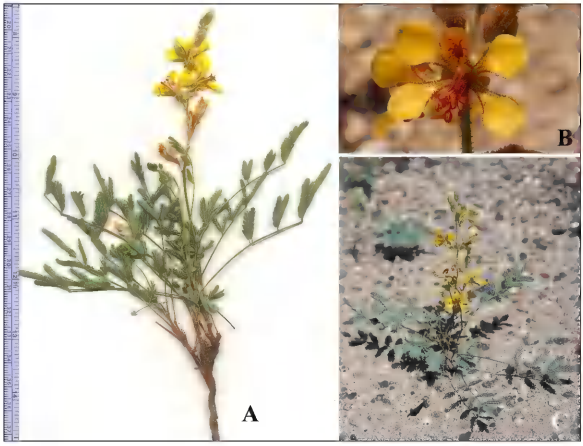

Figure 19. *Hoffmannseggia glauca*. (A & C) Ajo, 12 Sep 2013. (B) Dog Canyon Trailhead, Big Bend National Park, TX, 16 Apr 2007, photo by Patrick Alexander (SEINet).

Hoffmannseggia microphylla Torrey
[*Caesalpinia virgata* Fisher] Figure 20.

Shrubs to about 1 m tall, with many slender, rush-like slender stems and sparse foliage. New shoots, leafstalks, inflorescences, and buds with short white hairs but not stipitate glandular, the leaflets sparsely hairy or glabrate. Leaves few and widely spaced, quickly drought deciduous, 1.5–4.5 cm long, with 3 pinnae, the terminal one with 6–11 leaflet pairs, the lateral pinnae with 3–9 leaflet pairs; leaflets 2–3 (5) mm long. Inflorescences reaching 10–25 cm long. Flowers 13–15 mm wide, yellow, the banner with a yellow-brown or reddish arc, the sepals becoming orange with age. Pods 1.5–2 cm long, crescent-shaped, densely dotted with thick-stalked yellowish glands. Flowering various seasons including spring.

This species approaches the Tinajas Altas Region at the Fortuna Mine site on the west side of the Gila Mountains.

Southwestern Arizona, northwestern Sonora, southeastern California, and northeastern Baja California.

Yuma Co.: Foot of the Fortuna Mts (W side), 27 Mar 1935, stony wash, *Aven Nelson & Ruth A. Nelson 1298* (RM). Gila Mts near Fortuna Mine, 21 Feb 1979, *Bowers 1588*.

Figure 20. *Hoffmannseggia microphylla*. (A & B) Mecca Hills, Riverside Co., CA, 25 Feb 2012. (C) Near Cactus City Rest Area, Riverside Co. 9 Feb 2012. Photos by Keir Morse (CalPhotos).

Lotus, see **Acmispon**

Lupinus – Lupine, *lupino*

Spring annuals in the flora area (elsewhere also herbaceous perennials and shrubs). Leaves digitately compound, leaflets 5–13 (those in the flora area); stipules fused to petiole base. Flowers papilionoid, in terminal racemes. Stamens 10, the filaments fused (monodelphous), the anthers dimorphic (every other one longer and basifixed or shorter and versatile). Pods laterally compressed, several-seeded and obliquely depressed between the seeds, elastically dehiscent, the valves coiling to eject the seeds. Seeds resembling pebbles. Lupines have been in the flora area for at least 10,000 years. Both hemispheres; 220 species.

1. Leaflets narrow — linear to narrowly obovate or narrowly elliptic, the tips acute; flowers bright blue with a white "eye" spot on the banner petal..... **Lupinus sparsiflorus**
1. Leaflets relatively broad—obovate to elliptic, the tips mostly blunt to broadly rounded, often notched or apiculate; flowers pink to lavender-pink or pale blue (not bright blue).

2. Plants, especially the leaves, often essentially glabrous or sparsely to moderately hairy, the upper leaflet surfaces glabrous, the lower surface often hairy; flowers not minute, lavender-pink to pale blue..... **Lupinus arizonicus**
2. Plants conspicuously and densely hairy including both upper and lower leaflet surfaces; flowers minute, pink..... **Lupinus concinnus**

Lupinus arizonicus (S. Watson) S. Watson
[*L. concinnus* var. *arizonicus* S. Watson. *L. arizonicus* subsp. *sonorensis* J.A. Christian & D.B. Dunn] Arizona lupine; *lupino*; tas ha:hag. Figure 21.

Plants 12–60+ cm tall, the herbage often semi-succulent, with relatively coarse hairs and the leaflets moderately hairy or glabrate. Stems mostly erect to ascending, solitary to much-branched. Leaflets (5) 7–9 per leaf, (13) 15–37 × 4–12 mm, obovate, the tip mostly blunt to broadly rounded

and sometimes notched to apiculate (with a soft, blunt projection at the tip). Flowers pale lavender-pink, rarely white, the corollas 7–9 mm long. Pods (9) 15–24 mm long. Seeds 4–6 per pod, 2.8–3.1 mm long, smooth and marbled.

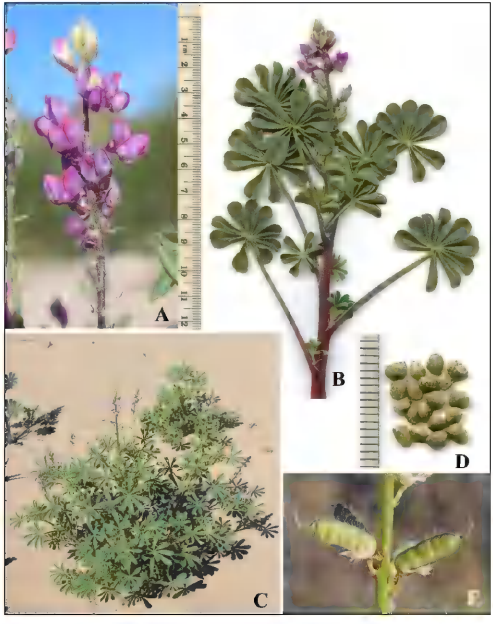

Figure 21. *Lupinus arizonicus*. (A) Hat Mtn area, Sauceda Mts, 22 Mar 2014. (B) Puerto Peñasco, 19 Feb 2015. (C) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, 15 Feb 2014. (D & E) Midway Wash at Hwy 85, Maricopa Co., 8 Mar 2015.

Widespread through the flora area in lowland habitats, especially washes, upper bajadas, sand flats and dunes, as well as often on rocky slopes; often abundant during favorable years in the western part of the region, and generally scarce towards the eastern part of Organ Pipe.

Southwestern Arizona and southeastern California to the Cape Region of Baja California Sur and coastal Sonora southward to the vicinity of Tastiota (28°20′N).

OP: Bates Well, *McDougall 21 Mar 1941*. S end of Cipriano Pass, 1350 ft, 30 Mar 1978, *Bowers 1113*. Aguajita Wash, 6 Apr 1988, *Felger 88-284*.

CP: Tule Tank, 23 Mar 1935, *Peebles 10891*. 3 mi E of Pinacate Lava Flow, 14 Apr 1964, *Niles 347*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3913*. Bassarisc Tank, 26 Feb 1993, *Felger 93-119*.

TA: Tinajas Altas, *Van Devender 25 Mar 1983*. Tinajas Altas Mts, Surveyors Canyon, canyon bottom below Surveyors Tank, 29 Mar 2010, *Felger 10-212*.

Lupinus concinnus J. Agardh
[*L. concinnus* var. *orcuttii* (S. Watson) C.P. Smith]
Bajada lupine. Figure 22.

Figure 22. *Lupinus concinnus*. (A & B) Midway Wash at Hwy 85, Maricopa Co., 8 Mar 2015. (C) Kuakatch Wash near Hwy 85, 3 Mar 2014. (D) Alamo Wash near Hwy 85, 26 Feb 2014.

Plants notably woolly (pilose), with long slender hairs, the leaves crowded and the stems usually short, the plants generally less than 15 cm tall. Leaves with 5–9 leaflets. Flowers crowded on spike-like racemes often shorter than the leaves. Corollas small and pink, the banner with a white or yellowish spot. Pods 1–1.5 cm long. Seeds 3–5 per pod.

Often on gravelly-sandy soil of open washes; widespread across the lowlands of the Arizona Upland region of Organ Pipe and the east side of Cabeza Prieta, and occasionally at higher elevations.

California to Utah and west Texas, Baja California, and northern Sonora.

OP: Growler Canyon, Bates Mts, 30 Mar 1979, *Bowers 1601*. Alamo Wash at bridge [Hwy 85], *Beale 1 Mar 1986* (ORPI). W branch of Cuerda de Leña at N boundary, *Rutman 16 Mar 1995* (ORPI). Alamo Canyon, 29 Mar 2003, *Felger* (observation). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-287*.

CP: Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, with *L. arizonicus* and *L. sparsiflorus*, *Felger 93-349*.

Lupinus sparsiflorus Bentham

[*L. sparsiflorus* subsp. *mohavensis* Dziekanowski & D.B. Dunn. *L. sparsiflorus* var. *mohavensis* Welsh]

Coulter's lupine, desert lupine. Figure 23.

Plants 12–45 cm tall, with coarse white to golden yellow hairs. Stems erect to ascending, solitary to much-branched. Leaflets 6–10 per leaf, 11–40 × 2–6 mm, linear to narrowly obovate or narrowly elliptic, the tips mostly acute. Flowers showy, the corollas 8–11 mm long, bright blue with a white blotch (eye) surrounding a yellow area with dark spots at the base of the banner. The white blotch becomes pink or violet when the flower is pollinated (Figure 23E & F). Pods 10–23 mm long. Seeds 3–8 per pod, 2.4–2.8 mm long, smooth (but less so than in *L. arizonicus*), tan, and marbled.

Washes, roadsides, hills, and mountains; Ajo Mountains, where it is the most common lupine and extends to higher elevations. Widespread in Organ Pipe except the more arid, lower elevations, and in the eastern part of Cabeza Prieta.

Arizona, northern Sonora, southern Nevada, southwestern Utah, and southern California to Baja California Sur.

OP: Growler Mts, *Crooks 31 Mar 1937*. Tres Alamos Canyon, 2700 ft, *Nichol 4 Feb 1939*. Pozo Nuevo, 30 Mar 1978, *Bowers 1096*. Puerto Blanco Drive, near marker no. 10, 12 Apr 1978, *Bowers 1260*. Trail above Bull Pasture, 3220 ft, 10 Apr 2005, *Felger* (observation).

CP: 0.5 mi N of Papago Well, 16 Mar 1992, *Yeatts 3222* (CAB). Bassarisc Tank, 26 Feb 1993, *Felger 93-120*. Charlie Bell Road near E boundary of Refuge, 9 Apr 1993, *Felger 93-327*. 4.7 mi E of Tule Well, 11 Apr 1993, *Felger 93-443*.

†**Lupinus** sp./spp.

OP: †Puerto Blanco Mts, seeds and seed fragments, modern (30) to 9860 ybp (7 samples).

TA: †Butler Mts, fruits, calyx, seeds, 740 & 3820 ybp. Tinajas Altas, seeds, 1230 to 9900 ybp (9 samples).

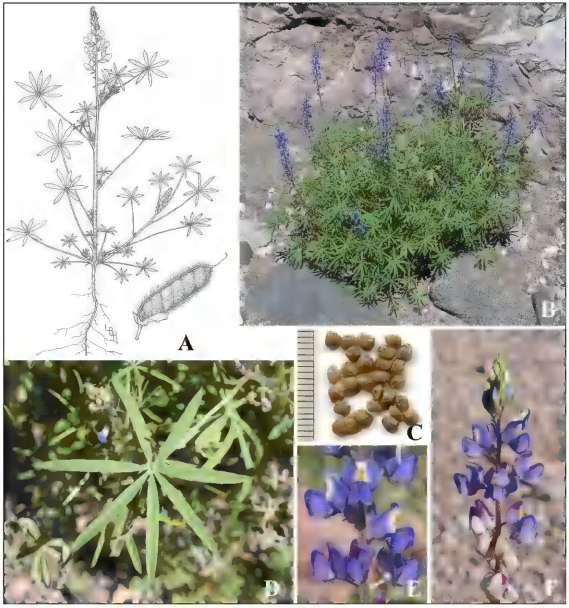

Figure 23. *Lupinus sparsiflorus*. (A) By Lucretia Breazeale Hamilton. (B) Pomeroy (aka Coffeepot) Wash at the Pipeline Road, Sauceda Mts, Maricopa Co., 27 Feb 2005. (C) Midway Wash at Hwy 85, Maricopa Co., 8 Mar 2015. (D) Coffeepot Mountain, Maricopa Co., 27 Feb 2005. (E) Estes Canyon, 2 Mar 2008. (F) Alamo Wash near Hwy 85, 26 Feb 2014.

Marina

Annuals, herbaceous perennials, and shrubs. Flowers papilionoid. Southwestern USA to northern South America; 38 species. A genus segregated from *Dalea*.

Marina parryi (Torrey & A. Gray) Barneby
[*Dalea parryi* Torrey & A. Gray]
Parry dalea, Parry's false prairie-clover. Figure 24.

Non-seasonal ephemerals, mostly growing with winter-spring rains, or occasionally short-lived perennials; with a yellow taproot. Stems erect to spreading, commonly 30–50 cm long,

sometimes reproducing at only 8–10 cm, rarely reaching 1.5 m across; dotted with maroon glands. New shoots usually densely pubescent with short, firm, appressed hairs, but during summer rainy seasons the plants sometimes becoming glabrate with only the stem tips pubescent. Leaves odd-pinnate, the terminal leaflet stalked; leaflets marked on upper surfaces with tiny wavy lines representing veins (these sometimes difficult to see on small leaflets of drought-stressed plants); leaves 2.5–3.5 cm long, green to grayish depending on density of hairs, the leaflets 13–29 per leaf, 1.5–6.5 mm long, underside dotted with glands. Small bracts subtend the buds but fall away before the flowers open. Flowers 2.8–5.9 mm long. Calyx 2.5–3.5 mm long, densely hairy but with a wide range in density and length of hairs, 5-toothed and 10-ribbed with prominent rows of reddish glands between the ribs; calyx teeth markedly shorter than the tube. Corollas dark blue and white. Stamens 9 or 10. Pods 1.8–2.5 mm long, 1-seeded.

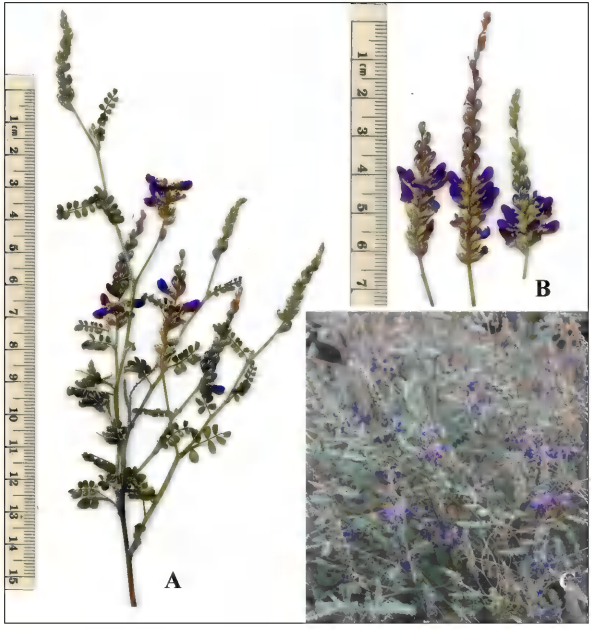

Figure 24. *Marina parryi*. (A & B) Ajo, 23 Mar 2015. (C) Estes Canyon, 18 Mar 2005.

Organ Pipe and Cabeza Prieta in many habitats including washes, plains, and rocky slopes. It was in the Puerto Blanco Mountains 9900 years ago.

The geographic range nearly coincides with the boundaries of the Sonoran Desert as defined by Shreve (1951), and over most of the region it is the only species of *Marina* present.

OP: Walls Well, *Nichol 28 Apr 1939*. Sinita Basin, 23 Mar 1969, *Keil 15424* (ASU). Alamo Canyon, 3 Dec 1977, *Bowers 986*. Aguajita, arroyo, 13 Sep 1986, *Felger 86-286*. †Puerto Blanco Mts, fruit, 9860 ybp.
CP: Agua Dulce Mts, 8 Apr 1979, *Lehto L23603* (ASU). Surprise Canyon, Cabeza Prieta Mts, 10 Mar 1984, *Hodgson 2736* (DES). E Pinta Sands, 15 Sep 1992, *Felger 92-755* (ASU, NY). About ¼ mi W of Chico Suni Well, in drainage, 2 Feb 2003, *Rutman 2003-16*.

***Medicago**

Annuals, herbaceous perennials, and shrubs. Flowers papilionoid. Mediterranean and Asia; 80 species.

****Medicago polymorpha** Linnaeus
[*M. hispida* Gaertner]
Burclover. Figure 25.

Annuals with decumbent, spreading branches. Leaflets 3. Flowers small and yellow. Pods less than 1 cm wide, bur-like and coiled, with several seeds.

Uncommon garden weed in disturbed habitat at Organ Pipe headquarters. Widespread weed, native to the Mediterranean region.

OP: Resource Center, 28 Feb 1985, *Bennett 8681* (ORPI). Research Center, not common, 30 Mar 1988, *Felger 88-142B* (ORPI).

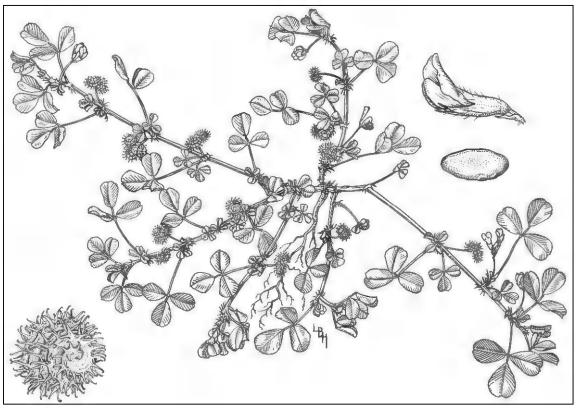

Figure 25. *Medicago polymorpha*. By Lucretia Breazeale Hamilton.

***Melilotus**

Annuals and herbaceous perennials. Flowers papilionoid. Mediterranean and Asia; 20 species.

***Melilotus indicus** (Linnaeus) Allioni
[*Trifolium melilotus* var. *indicum* Linnaeus]
Yellow sour-clover; yellow sweet-clover; *trébol agrio*; pu:wl. Figure 26.

Non-seasonal annuals; glabrous, the stems mostly erect to ascending; the dry herbage fragrant. Leaflets 3, each 1–3 cm long, ovate to obovate, the margins serrated mostly toward the tip, or occasionally some leaflets essentially entire. Flowers yellow and fragrant, 3–4.5 mm long, turning downward after anthesis, in spike-like racemes. Pods 2.5 mm long, indehiscent, reflexed, ovoid, and wrinkled; 1-seeded.

Localized on moist soils at Quitobaquito and occasional weed in the residence area in Organ Pipe. Common in disturbed wetland habitats in Sonora just south of Quitobaquito including sandy riverbanks and floodplain of the Río Sonoyta and in Sonoyta.

Widespread weed, native to the Mediterranean region.

OP: Quitobaquito: 25 Mar 1944, *Clark 11511* (ORPI); 30 Mar 1979, *Bowers 1607*; Common along irrigation ditch below pond, 26 Apr 1990, *Felger 90-92* (ARIZ, ASU). Residence Area, 30 Mar 1988, *Felger 88-142*.

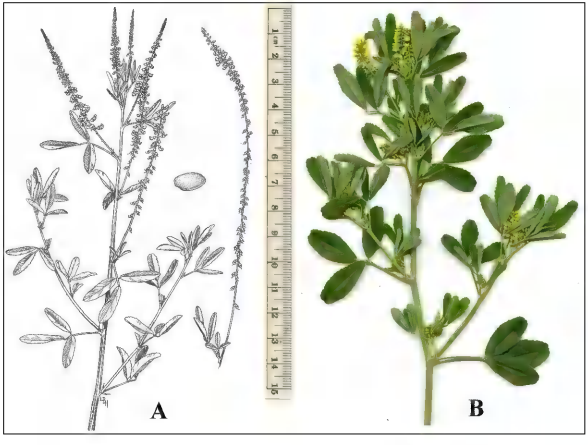

Figure 26. *Melilotus indicus*. (A) By Lucretia Breazeale Hamilton. (B) Ajo, 13 Mar 2015.

Mimosa

Herbaceous perennials, shrubs, and trees. Flowers mimosoid. New World, mostly Neotropical; 530 species.

Mimosa distachya Cavanilles var. **laxiflora** (Bentham) Barneby
[*M. laxiflora* Bentham]
Arizona mimosa; *garabatillo, uña de gato*. Figure 27.

Shrubs to 2.6 m tall, the stems with sharp, recurved internodal prickles (spines) 2–3 (6) mm long or some stems or portions of stems unarmed. Leaves (3.5) 6–8 cm long, with 2–4 pairs of pinnae, twice pinnate; drought- and cold-deciduous. Flowers in cylindrical spike-like racemes; flowering with summer rains in August and September. Calyx pink. Stamens 8–10; filaments lavender-pink, fading to white, the anthers whitish. Pods 4.5–5.5 × 5–9 mm, multiple-seeded, forming 1-seeded, quadrangular segments separating from each other and from the rim.

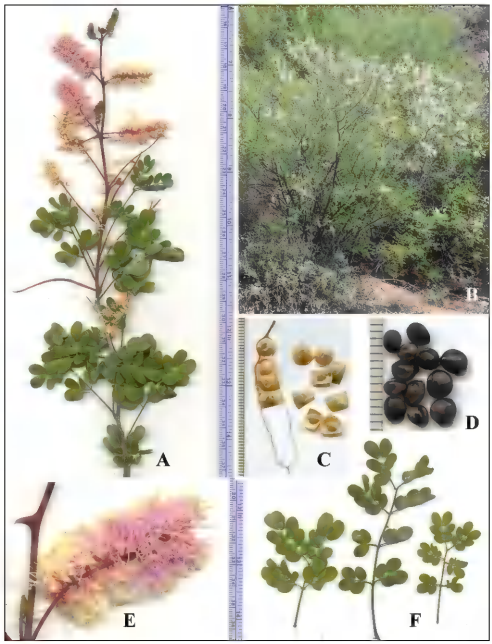

Figure 27. *Mimosa distachya* var. *laxiflora*. Ajo Mountain Drive, 0.5 mi S of Estes Canyon picnic area: (A, E, & F) 14 Aug 2013; (B) 2 Aug 2013; (C) 7 Sep 2014; (D) 12 Sep 2014.

Rocky slopes and canyon bottoms in the Santa Rosa, Diablo, and Ajo mountains. It is especially common at the base of Diaz Peak and Diaz Spire in the southern Ajo Mountains.

Var. *laxiflora* occurs in western Pima County, Arizona to Sinaloa and western Chihuahua. *Mimosa distachya*, with four varieties, extends to southern Mexico.

OP: Ajo Mts at International boundary [Santa Rosa Mountains], *Supernaugh 3 Aug 1947* (ORPI). Estes Canyon, wash, 2400 ft, 12 Sep 1978, *Bowers 1517*. Santa Rosa Mts at International boundary, *Rutman 29 Aug 2001* (ORPI). W side and base of Sierra Santa Rosa, 1640 ft, small canyon through black lava, shrubs 1.8-2.6 m tall, 12 Mar 2003, *Felger 03-306*. Small wash between Ajo and Diablo Mts, along Ajo Mountain Drive, S of Estes Canyon Picnic Area, 2320 ft, 8 Aug 2013, *Rutman 20130808-3*.

Nissolia

Perennial vines and shrubs. Flowers papilionoid. Southwestern USA to South America; 13 species.

Nissolia schottii (Torrey) A. Gray
[*Chaetocalyx schottii* Torrey]
Schott's yellowhood. Figure 28.

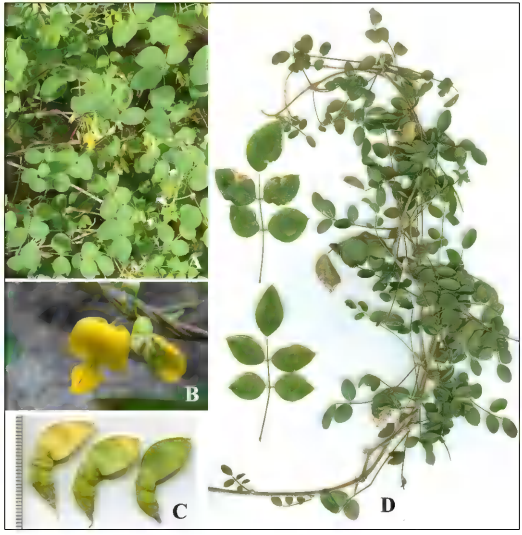

Figure 28. *Nissolia schottii*. (A) Arch Canyon, 2 Aug 2013. (B) Lower Josephine Canyon, Santa Rita Mts, Santa Cruz Co., 26 Jul 2013, photo by Sue Carnahan. Bull Pasture Trail: (C) 19 Sep 2014; (D) 16 Mar 2008.

Unarmed perennial vines, often twining on shrubs and trees; glabrous or glabrate. Leaves once pinnate with 5 leaflets, and gradually drought and winter deciduous. Leaflets broadly ovate or elliptic, 1–2 cm long, often with a mucronate tip; stipules inconspicuous. Flowers 1–5 in leaf axils; pedicels slender. Corollas bright yellow; banner petal with closely set vertical grooves giving a pleated appearance. Stamens 10, the filaments united into a tube. Pods indehiscent, papery-winged, and samara-like, with 1–3 (4) seeds. Flowering during warmer months, especially with summer rains.

Ajo and Santa Rosa mountains; common in canyons and on rocky slopes.

Eastward in southern Arizona and southward to southern Sonora and western Chihuahua.

OP: Bull Pasture Trail, 5 Nov 1977, *Bowers 939*. Arch Canyon, *Wirt 13 Oct 1990* (ORPI). Ajo Mts, crestline above middle fork of Alamo Canyon, 15 Mar 2003, *Rutman 2003-338* (ORPI). Diablo Mts, 2740 ft, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-15*.

Olneya

This genus has a single species. Flowers papilionoid.

Olneya tesota A. Gray.

Ironwood, desert ironwood; *palo fierro, tesota*; ho'idkam. Figure 29.

Large shrubs or trees 5–8.5 (10) m tall, long-lived and slow growing, with 1 to several massive trunks, and dense foliage often bright green from June (after pods drop) to September and becoming grayish green after the summer, although often becoming leafless or nearly so prior to flowering in spring. Trunks have shredding gray bark, mid-sized branches have smooth gray bark, and branchlets are greenish. Herbage with dense, short, relatively coarse whitish hairs, the leaflets sometimes sparsely hairy and appearing glabrous except under magnification. Many twigs bear single or paired spines at the nodes, the spines (3) 4–11 mm long, slender to thickened at base, sharp, straight to slightly curved, or spines absent from some twigs. Leaves gradually deciduous in extreme drought or deciduous prior to flowering, odd- or even-pinnate, mostly 3–9 cm long. Leaflets opposite, subopposite, or sometimes alternate, 6–16 per leaf, (7) 10–20 mm long, oblong to mostly oblong-spatulate, often slightly asymmetric (especially toward base), the tip entire, notched, or sometimes with a minute apiculate projection.

Flowers pale to dark pink-lavender; mass flowering in late April and May during years of sufficient rainfall, attracting myriads of bees and other insects. Each tree or population might not flower each year. Inflorescence branches, pedicels, sepals, and portion of banner petal exposed in bud densely pubescent with short white hairs. Flowers ca. 1.5 cm long, pedicelled, in short, dense racemes or panicles. Calyx purple-brown, the lobes about as long as the tube, spreading at anthesis. Petals pinkish to purplish on exposed portions of the blades, white below. Banner petal with a thickened, succulent, white callus at junction of blade and claw, the flat blade of the banner folding back later in the day behind a protruding nectar guide. The nectar guide invaginated and chartreuse on the banner above the callus, with a whitish band surrounding and highlighting the nectar guide and margined with red-purple apically. Wing and keel petals reddish purple (darker than the other petals). Stamens 10, the filaments white, the upper stamen free, the others with the filaments united into a tube. Anthers yellow-orange. Style pale green, the distal portion with spreading hairs forming a pollen brush, the stigma yellow-orange like the anthers. Ovary densely studded with white, thick-stalked, globular glands except at its distal end.

Pods often 2–6 cm long, thick and mostly constricted between the seeds, with stout, glandular hairs and shorter non-glandular hairs; tardily dehiscent, the valves spreading from the tip and not twisting. The pods are yellowish brown until mature, when they become a cinnamon color

and harden. The valves open with a snap in the early morning light but most seeds remain inside. Seeds 1–4 (6) per pod, ca. 7–8 mm long, ellipsoid, mostly 50% longer than wide, dark purplish brown, and darkly mottled.

Figure 29. *Olneya tesota*. (A) By Cathy Moser Marlett. Organ Pipe headquarters: (B & D) 14 May 2006; (C) 5 Aug 2006; (E) 10 May 2005; (G) 15 Sep 2008. (F & H) Near international boundary, La Abra Plain, 3 Jul 2006; this tree, with a massive crop of pods, is nearly leafless.

Widespread along washes, major drainageways, bajada-plains, mountain canyons, and infrequent and usually of smaller stature on rocky slopes. A number of mighty ironwoods in the Tinajas Altas Region are scattered about the arroyo-wash between the Mesa del Muerto and the lower tinajas. The largest known ironwood in the region is more than 10 m tall with a massive trunk (photo in Felger et al. 2012). The 9900-year-old Tinajas Altas record is the oldest known for ironwood.

Southeastern California to the Cape Region of Baja California Sur and southwestern Arizona to southwestern Sonora; essentially endemic to the Sonoran Desert but extending beyond the desert in the lowland thornscrub of the Cape Region and in southwestern Sonora. *Olneya* seeds are smaller in the north (Arizona) than in the south (southern Sonora), seeming to represent a latitudinal cline in seed size and weight (Felger 1979: 17). *Olneya* has no obvious close relative. Matt Lavin's work (Lavin 1988; Lavin & Sousa 1995) places *Olneya* with a group of genera including *Coursetia* that are of South American origin.

Olneya is one of the most common and important trees in the region and one of the longest-lived trees in the Sonoran Desert. It has long been an important source of wood and fuel. Many large, axe- or saw-cut ironwood stumps can be seen throughout the region, especially along old roads. Edward Havins (pers. comm. to Sue Rutman, 2001) said that fuel wood was so limited in the 1920s and 1930s that people were stealing dynamite from the (Ajo) mine and blowing up ironwood trees. There are very few large, old ironwoods left in the flora area because of woodcutting. The open niches left by ironwood removal were taken by palo verdes and mesquites, which are not as long-lived and do not have the habitat structure that some birds prefer, e.g. cactus ferruginous pygmy-owl. Bryan (1925: 422) wrote that, at Tinajas Altas, "A few palo verde or ironwood trees are still standing and may furnish horse feed, but the traveler should bring his own firewood." *Olneya* is one of the favorite foods of desert bighorn and many small mammals and a prominent "nurse plant" for cacti, especially saguaros, and numerous other plant species (e.g., Turner et al. 1995). Tim Tibbitts was monitoring Sonoran pronghorn in the Valley of the Ajo on 13 May 2013 and watched them eat *Olneya* and *Parkinsonia microphylla* flowers as well as *Phoradendron californicum* for hours. There are other, unrelated trees in different regions that are also called ironwood because they have extremely hard wood, so dense that it does not float in water.

Ironwood seeds, harvested in early summer, were probably a significant resource. It is one of the few Sonoran Desert foods that was cooked in changes of water, or water-leached (Castetter & Bell 1951; Felger & Moser 1985). The seeds were variously prepared for food, including by the Hia-Ced O'odham (Felger 2007a). "They would roast the seeds and grind it and eat it" (Betty Melvin, in Zepeda 1985: 82, also 47, 59). Lumholtz (1912: 331) reported the seeds "were toasted, ground, and consumed as pinole." An infusion of the sapwood was drunk by the Seris as an emetic, to prevent breathing hard when running and to obtain power or visions during the vision quest (Felger & Moser 1985). The extremely hard wood was used in many ways, including as digging sticks with fire-hardened points, fences, firewood, house posts, musical rasps, utensils, and war clubs (Castetter & Bell 1942; Castetter & Underhill 1935; Gifford 1933; Rea 1997) and by the Seris for sculptures (e.g., Felger & Moser 1985).

OP: Quitobaquito, *Nichol 28 Apr 1939*. Alamo Canyon, 20 Apr 1942, *Cooper 577*. 3 mi N of Bates Well, *Tinkham 23 Apr 1942*. South Puerto Blanco Drive 2.5 mi W of Hwy 85, 11 Aug 1990, *Felger 90-403*. †Puerto Blanco Mts, on ridge, twigs with spines, leaflets, 1910 to 7560 ybp (8 samples).

CP: Observations: Agua Dulce Mts, Little Tule Well, 12 Jun 1992, *Felger*; Bajada on N side of Sheep Peak, 31 Jan 1992, *Felger*.

TA: Tinajas Altas, wash just E of the tinajas, 20 Nov 2008, *Felger 08-171*. Frontera Canyon, 18 Mar 1998, *Felger* (observation). †Butler Mts, spines, leaves, fruits, 740 to 8570 ybp (3 samples). †Tinajas Altas, twigs with spines, leaflets, 1230 to 9900 ybp (4 samples).

Parkinsonia – palo verde

Trees and large, heavy-branched shrubs with smooth green bark (except older branches and trunk) and relatively soft wood. Twigs with paired stipular spines, or stipular spines absent and the twigs spinescent. Short shoots very reduced. Leaves twice pinnate with 1–3 pairs of pinnae, petioled or the pinnae sessile and the leaves then appearing once pinnate. Leaflets small, the leaflets and leaves quickly drought deciduous, the leaflets often falling independently. Flowers caesalpinioid and showy, produced in prodigious quantities in spring; banner petal yellow or whitish and often with orange spots or flecks, and often becoming orange or orange-flecked with age, the other petals yellow. Stamens 10, separate; anthers orange. Pods ripening in early summer, indehiscent to tardily partially dehiscent, seeds 1–several.

Botanical bickering about the approximately 12 species belonging to a single genus (*Parkinsonia*) or two genera (*Cercidium* and *Parkinsonia*) had been going on for more than a century, although most recently the one-genus camp has won as the species form a strongly monophyletic taxon (e.g., Haston et al. 2005; Hawkins et al. 1999; Krings, accepted for publication). *Parkinsonia* in the narrow sense includes three species in Africa plus *P. aculeata* widespread in both hemispheres. *Cercidium* ranges from the southwestern USA to Argentina. Selection of a hybrid found in the Tucson region, a cultivar called "Desert Museum," involves hybridization of *P. aculeata*, *P. florida*, and *P. microphylla* (Dimmitt 1987). It is propagated by cuttings and widely planted in southern Arizona.

1. Leaves more than (10) 20 cm long..... **Parkinsonia aculeata**
1. Leaves less than 7 cm long.

2. Twigs not spinescent at tip; solitary or paired axillary spines often present; leaves petioled, the leaflets mostly 5–9 mm long..... **Parkinsonia florida**
2. Twigs spinescent at tip; axillary spines absent; petiole absent, leaves with two sessile pinnae, the leaflets mostly 1–3.5 (6) mm long..... **Parkinsonia microphylla**

****Parkinsonia aculeata** Linnaeus

Mexican palo verde; *bagote, retama, guacapora*. Figure 30.

Trees with a well-developed trunk. Leaves of long shoots bearing long slender pinnae (each pinna resembling an individual leaf), the actual leafstalk (petiole and primary leaf rachis) modified into a very stout, stiff, sharp spine; the stipules form sharp spines. The pinnae, appearing as the leaves, (10) 20–45+ cm long, slender and strap-shaped, with numerous small leaflets. Short-shoot leaves mostly spineless. Flowers bright yellow; mass flowering in late spring. Pods few-seeded.

Occasional plants found in disturbed areas near Lukeville and a few near the highway between Lukeville and Organ Pipe headquarters, apparently spreading from trees planted or weedy in Lukeville or near the border in Sonora.

Cultivated and naturalized worldwide in warm regions. Native to tropical America (Hawkins et al. 2007).

The seeds (probably the seed coats) are bitter and probably toxic (Felger 2007a; Hodgson 2001). Reports of the seeds being eaten (e.g., Castetter & Bell 1942: 60) should be viewed with caution. Gentry (1942) reports that in southeastern Sonora the fresh, green seeds were eaten raw after peeling off the seed coat.

OP: Lukeville, 0.1 mi W of Hwy 85, single tree, 12 May 2003, *Rutman 2003-524*. Disturbed area, Hwy 85 ca. 1.5 mi S of visitor center, 2 plants, 2+ m tall, 4 Nov 2003, *Rutman* (observation). Near Ajo Mt Wayside (parking area) Hwy 85, *Rutman 26 Jun 2007* (single plant ca. 2 m tall, growing in disturbed area following construction of the Wayside interpretive site, the plant removed).

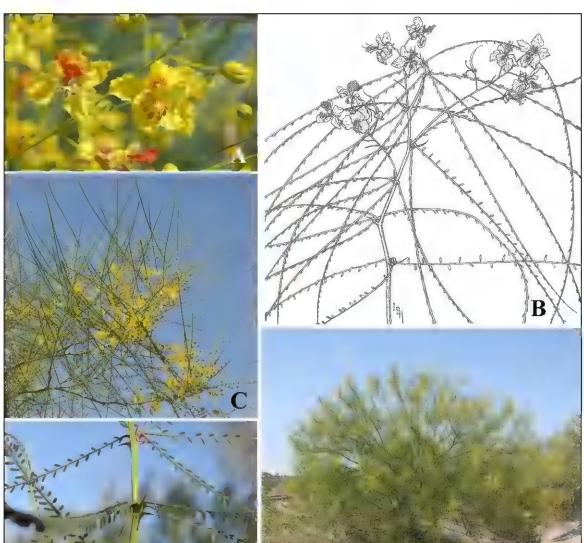

Figure 30. *Parkinsonia aculeata*. Ajo: (A, C, & E) 6 May 2006; (D) 2 Sep 2005. (B) By Lucretia Breazeale Hamilton.

Parkinsonia florida (Bentham ex A. Gray) S. Watson
[*Cercidium floridum* Bentham ex A. Gray]
Blue palo verde; *palo verde*; ko'okomadk, kalisp. Figure 31.

Large shrubs to small trees reaching 7–10 m tall, with a well-developed trunk. Bark of twigs and branches, smooth, and bluish green. Leaves short petioled, usually with 1 pair of pinnae, each 5–12 mm long and usually with 3 or 4 pairs of leaflets, the leaflets 5–9 mm long; often with stalked or cylindrical glands at the base of pinnae and between the leaflets (on upper surfaces), darkening when dried. Blazing yellow masses of flowers occur in spring, the peak usually late March–early April (about two weeks in advance of flowering of *P. microphylla*); also sometimes sparsely flowering in fall. Flowers (18) 22–28.7 mm wide. Calyx green to yellow-green, the lobes reflexed. Petals bright

yellow, the banner with a few small orange-red spots basally, or the spots absent. Filaments and petals with long white hairs at their bases; filaments bright yellow. Ovary sparsely pubescent at base, otherwise glabrate. Pods 3–7 (10) × 1.1–1.4 cm, moderately flattened, mostly indehiscent, generally not constricted between the seeds; seeds 1–6. Prodigious crops of pods usually ripening in May and June.

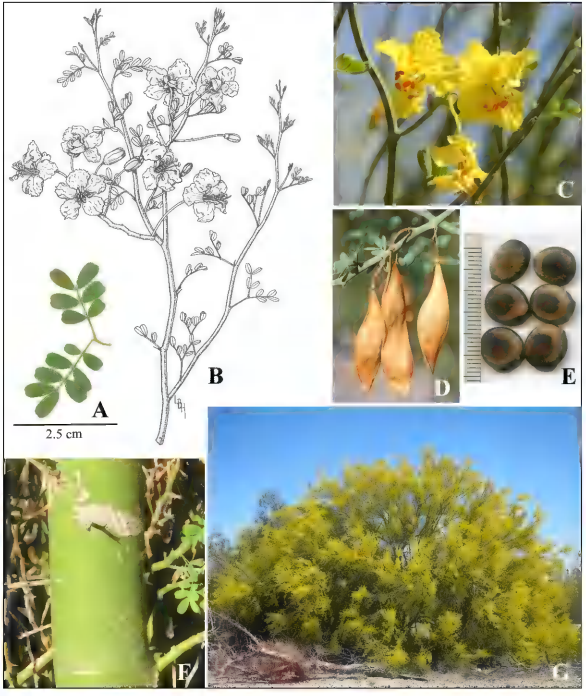

Figure 31. *Parkinsonia florida*. Ajo: (A) 7 Oct 2008; (E) 21 Dec 2014. (B) By Lucretia Breazeale Hamilton. (C) Eagle Pass near Hwy 85, 6 May 2005. (D) Growler Canyon, Bates Mts, 9 Sep 2012. Kuakatch Wash near Hwy 85: (F) 8 Oct 2008; (G) 12 Apr 2011.

One of the several larger trees in the region. Widespread; mostly along larger canyons and drainageways of the desert floor, and often on dunes, and occasionally on rocky slopes. It has been in the flora area for more than 8300 years and was at least sometimes common.

Blue palo verde trees are fairly common in canyon bottoms and the larger washes along the eastern side of the Tinajas Altas Mountains, such as the broad wash leading out of Borrego Canyon, and many of the small washes on the upper bajada. Only two or three blue palo verdes, however, were found between 2000 and 2006 in the wash below the Tinajas Altas. The absence of more of the trees was perhaps due to earlier woodcutting, but by 2008 even these trees were gone, apparently due to drought and firewood collecting by visitors. Although the soft wood is of poor quality for fuel, it was utilized because little else was available. The trees were numerous on the Davis Plain west of the Gila Mountains, although many of them perished during extreme drought of 2004 and 2005. Palo verdes and ironwoods were not seen along Coyote Wash in the vicinity of Coyote Water, but palo verde and ironwood occur only 8 km southward in La Jolla Wash. At the northern end of the Tinajas Altas Region, blue palo verde replaces foothill palo verde in certain unexpected circumstances, such as among the basalt boulders of Raven Butte—hardly typical habitat, but the basalt is a veneer atop coarse granitic alluvium, and perhaps well drained and not so different from an arroyo.

Southern Arizona to northwestern Sinaloa and southeastern California to Baja California Sur.

The seeds, available in early summer, were generally considered less desirable and less important than those of *Parkinsonia microphylla*, although prepared in essentially the same manner (Felger & Moser 1985; Hodgson 2001). The seeds and sometimes the flowers and young green pods were eaten by the Cahuillas, Gila River Pimas, Hia-Ced O'odham, and Seris (Bean & Saubel 1972; Felger & Moser 1985; Felger et al. 1992; Rea 1997). The soft wood was used for utensils and sometimes for fuel (Felger et al. 1992; Felger & Moser 1985). The seeds are an important food for many small mammals.

OP: Bates Well, *Nichol 26 Apr 1939*. Pozo Nuevo, 17 Apr 1985, *Bennett 8771* (ORPI). Puerto Blanco Drive 2.4 mi W of Hwy 85, 19 Jun 1989, *Felger 89-228*. †Puerto Blanco Mts, on ridge, twigs, 5240 to 9720 ybp (5 samples; 7560 to 7970 ybp, in 3 samples, common to abundant; the site is on a rocky slope, today *P. florida* occurs below the slope in an arroyo bed).

CP: Papago Well, 11 Apr 1978, *Lehto L22488* (ASU). Pinta Sands, 11 Apr 1993, *Felger 93-415*.

TA: W side of Tinajas Altas Pass, 1100 ft, wash, 8 Mar 1986, *Van Devender 86-11*. Borrego Canyon, 16 Jun 1992, *Felger* (observation). Camino del Diablo, E of Raven Butte, 25 Oct 2004, *Felger* (observation). Canyon wash at NW side of Raven Butte, 30 Dec 2005, *Felger* (observation). E side of Tinajas Altas Mts, 2.5 mi SE of Tinajas Altas, major wash from first canyon N of Surveyors Canyon, 1160 ft, trees 5–6 m tall with a well formed trunk, some with bright yellow flowers and green pods, 22 Nov 2008, *Felger 08-195* (ARIZ, ASU, BRIT, CAS, DES, MPO, RSA, SNM). †Butler Mts, twigs, spines, fruits, 740 & 3820 ybp. †Tinajas Altas, twigs, spines, 4010 & 8255 ybp.

Parkinsonia microphylla Torrey

[*Cercidium microphyllum* (Torrey) Rose & I.M. Johnston]

Foothill palo verde; *palo verde*; kek cehedagi. Figure 32.

Small desert trees or large shrubs to 5 m tall, with thick limbs branching from near the base of a very short, thick trunk; bark smooth and yellowish green. Leaves lacking a petiole, with 1 pair of pinnae, each pinna 1–5.3 cm long (each sessile pinna might be confused for a single, once-pinnate leaf), with 4–8 (10) pairs of leaflets, the leaflets 1–3.5 (6) mm long, broadly elliptic to broadly oblong or sometimes orbicular; pulvini conspicuous at the base of leaflets, less conspicuous at the base of pinnae; individual leaflets and ultimately the leafstalks drought deciduous. Twigs glabrate with age; youngest, emerging herbage protected by short, stiff, white hairs and glands, the glands clustered at leaflet bases, 0.1 mm diameter, globular, and translucent on youngest twigs, dark brown with age.

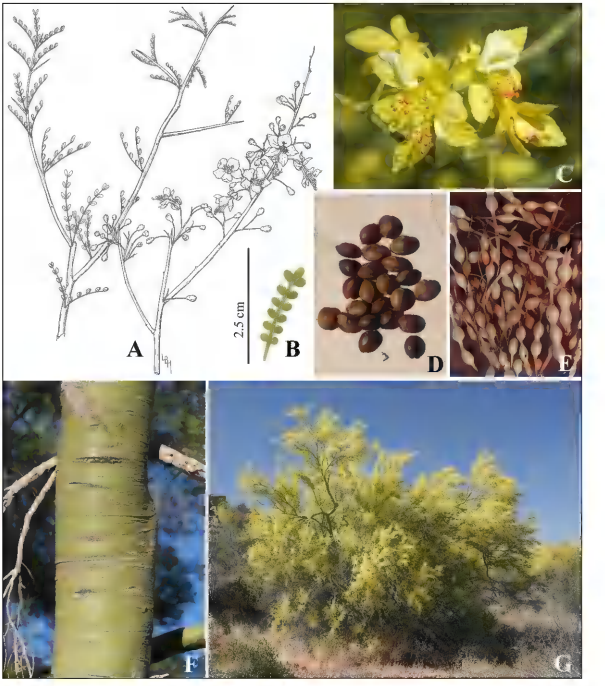

Figure 32. *Parkinsonia microphylla*. (A) By Lucretia Breazeale Hamilton. Ajo: (B) 24 Jul 2014; (C) 6 May 2005; (D & E) 5 Aug 2006. (F) Kuakatch Wash near Hwy 85, 8 Oct 2008. (G) Eagle Pass, Hwy 85, 10 May 2005.

Masses of pale yellow flowers, mostly April–early May, the pods ripening late May–June. Peduncles and pedicels with short white hairs similar to those on the young herbage. Flowers (10) 12–18 mm wide. Calyx tube green to yellow-green, the lobes pale yellow, spreading to reflexed (not as strongly reflexed as in *Parkinsonia florida*). Banner (upper) petal white, with age becoming pale yellow and then orange-flecked or not, the other 4 petals pale yellow. Filaments pale yellow, with long white hairs below. Ovary and young green fruits densely white pubescent. Style and stigma pale yellow. Pods sparsely pubescent, 3–9.5 × 1 cm, indehiscent to tardily and partially dehiscent,

onstricted between the seeds, the tip often extending into a slender, sterile snout. Seeds 1–5 per pod, hard, and ovoid, 8.3–9.4 × 6.8–7 mm.

The severe drought of the mid-2000s caused a notable dieback of *Parkinsonia microphylla* and *P. florida* in the flora area. A study of dieback and episodic mortality in 1000 *P. microphylla* plants at the Desert Laboratory on Tumamoc Hill, Tucson, determined that diebacks tended to occur during severe deficits in annual, especially summer, rains. Severe drought caused disproportionally more mortality in older plants than younger ones (Bowers & Turner 2001).

Widespread and abundant across the flora area, mostly on slopes and bajadas away from larger watercourses. In the Tinajas Altas Region it is found on upper bajadas on the east side of the mountains and in canyons, washes, and rocky slopes from the base to higher elevations on all slope exposures. Its history in Organ Pipe extends back 5300 years.

Sonoran Desert from southwestern Arizona to the Guaymas Region in Sonora, both Baja California states, and California at a few stations along the Colorado River.

Tim Tibbitts was monitoring Sonoran pronghorn in the Valley of the Ajo on 13 May 2013 and watched them eat *Parkinsonia microphylla* flowers for hours, along with *Olneya* flowers and *Phoradendron californicum*. The seeds, harvested in early summer, provided an important food resource for the Cahuillas, Cocopahs, Gila River Pimas, Hia-Ced O'odham, Seris, Tohono O'odham, and other Sonoran Desert people (Bean & Saubel 1972; Bell et al. 1980; Bell & Castetter 1937; Felger & Moser 1985; Felger et al. 1992; Hodgson 2001; Rea 1997; Betty Melvin in Zepeda 1985: 47, 61–62). The seeds were parched, ground into flour, and generally consumed as a gruel, and they were often stored. Hia-Ced O'odham baked the flour with deer fat and water to make a bread-like mass (Fernando Flores in Bell et al. 1980). The flour was also sometimes mixed with ironwood or mesquite flour (Nabhan et al. 1979; Russell 1908). The Seris ate the flowers fresh or cooked, cooked the young green pods with meat, and often got the seeds by robbing packrat nests (Felger & Moser 1985). Fresh green seeds were eaten as snacks (Felger & Moser 1985; Hodgson 2001). The wood was used for utensils, digging tools and pry bars, small sculptures, and sometimes fuel (Castetter & Bell 1942; Felger & Moser 1985).

Betty Melvin said "The beans of the palo verde, yes they would gather it and then they would grind the beans of the palo verde, and they would roast them and grind it again. And it would turn into a floury substance, or else it would be loosely ground and crunchy. They would salt it . . . . Even the children would prepare it themselves, because it was simple and everybody ate it" (Betty Melvin in Zepeda 1985: 47, 61, 62). "We would get the foothill palo verde beans and we would soak them and then we would fry it until they popped. They tasted like peanuts" (Betty Melvin in Zepeda 1985: 77).

OP: Alamo Canyon, 2000 ft, 20 Apr 1942, *Cooper 561*. 2.4 mi W of AZ Hwy 85 on Puerto Blanco Drive, 1500 ft, sandy-gravelly wash, 19 Jun 1989, *Felger 89-227*. Quitobaquito, 24 Oct 1990, *Felger 90-492*. †Puerto Blanco Mts, on ridge, twigs, leaflets, modern (30) to 5240 ybp (12 samples).

CP: Agua Dulce Mts, Buck Mt Tank, Buckhorn Tank, Cabeza Prieta Tanks, Charlie Bell Road near E Refuge boundary, Little Tule Well, Senita Tank, Tuseral Tank, 12–15 Jun 1992, *Felger* (observations).

TA: Frontera Canyon, 18 Mar 1998, *Felger* (observation). Tinajas Altas Canyon, vicinity of uppermost tinajas, 21 Nov 2008, *Felger 08-177*.

Phaseolus – Beans; *frijoles*

Annual and perennial vines. Pubescence often of small, straight hairs and small, hooked hairs (seen with 20× magnification). Leaves prominently petioled, with 3 leaflets. Flowers papilionoid,

small, and pink. Calyx 5-lobed, the keel petal bent across the flower and twisted above the bend (a key character of this genus). Stamens 10; 9 united, 1 free. Pods multiple seeded, flattened, and explosively dehiscent, the valves twisting (the cultivated beans have indehiscent pods). Americas; 65 species.

1. Leaves "rough" and dry to the touch with small, recurved hairs; leaflets entire or essentially so; pods about the same width throughout..... **Phaseolus acutifolius**
1. Leaves smooth, with small, straight hairs or glabrate; leaflets generally 3-lobed; pods narrowest at base, broader toward the tip..... **Phaseolus filiformis**

Phaseolus acutifolius A. Gray var. **acutifolius**
[*P. acutifolius* var. *latifolius* G.F. Freeman. *P. acutifolius* var. *tenuifolius* A. Gray]
Tepary (wild); *tépari del monte*; bavï. Figure 33.

Figure 33. *Phaseolus acutifolius* var. *acutifolius*. Bull Pasture Trail: (A) 24 Sep 2006; (B) 21 Sep 2008. Alamo Canyon above the well: (C) 9 Sep 2013; (E) 17 Oct 2013. (D) Garden Canyon, Huachuca Mountains, 24 Aug 2010, photo by Jillian Cowles.

Annuals growing with summer and early fall rains, producing slender vines climbing through desert shrubs and small trees. Herbage with slender, recurved hairs. Leaflets mostly ovate, probably often to 5+ cm long, the margins generally entire. Petals pink. Pods about 5–6 cm long, several-seeded, and dehiscent, the valve coiling. Seeds 3.5–5 mm long, dark grayish and mottled, resembling gravel.

Seasonally abundant in the Ajo Mountains at middle to higher elevations where it is common on slopes. This is the westernmost population of this species.

Southern Arizona to western Texas and southward to Jalisco.

The green pods were gathered and dried, and the seeds ground into flour (Felger 2007a; Nabhan & Felger 1978). The wild tepary, unlike the domesticated tepary, has pods that burst open explosively when ripe and the seeds are smaller.

OP: Arch Canyon: *Wirt 13 Oct 1990*; Steep rocky NE-facing slope near the arch, 26 Oct 2003, *Rutman 20031026-25* (ORPI).

****Phaseolus acutifolius** var. **latifolius** G.F. Freeman
Tepary (cultivated); *tepari*; bavĭ

Teparies, the traditional cultivated beans in the region, were grown wherever agriculture was practiced, including oases such as Quitobaquito (Burrus 1971; Castetter & Bell 1951; Felger 2007a; Felger et al. 1992; Gifford 1933; Kelly 1977; Nabhan & Felger 1978; Rea 1997; Betty Melvin in Zepeda 1985: 65). Kino and Manje obtained beans, presumably teparies, at Sonoyta, Sonora, on February 16, 1699 (Burrus 1971).

The cultivar is readily distinguished from the wild teparies by always having broad leaflets, and indehiscent and larger pods, and larger seeds with a multitude of genetically stable differently colored seeds (e.g., Delagado-Salinas 1985; Frytag & Debouk 2002; Nabhan & Felger 1978; Pratt & Nabhan 1988). Freeman (1912) described the tepary cultivar as var. *latifolius*. However, the type specimen he cited is a wild plant, not the cultivar (Alfonso Delgado, pers. comm. to Felger, June 2015). Therefore, var. *latifolius* appears to be a *nomen confusum* because it has been assigned to two materials (an impossible treatment according to the Code of Botanical Nomenclature) — the broad-leaved wild tepary and the cultivar tepary (see Debouck 1991).

Pima Co.: Topawa, E. Chico field, growing in a field, *Nabhan 17 Oct 1981* (DES 39382 and 40488).
Sonora: Suvuk, E of Pinacate Peak, floodwater field crop, *Nabhan 25 Sep 1982* (DES).

Phaseolus filiformis A. Gray
[*P. wrightii* A. Gray]
Desert bean; ban bavĭ, cepuliñ bavĭ. Figure 34.

Non-seasonal annual vines, mostly in spring; with a well-developed taproot. Herbage and inflorescences moderately to sparsely pubescent or glabrate. Stems twining or sprawling. Leaflets (1) 2–5 cm long, thin, highly variable in size and shape, often ovate, generally 3-lobed, sometimes entire, often smaller and narrower toward stem tips and with drier conditions. Flowers 6–9 mm long, the petals pink. Pods 1.5–3+ cm long, slightly curved, laterally flattened, broadest above the middle, explosively dehiscent, the valves twisting. Seeds 3–3.9 × 1.6–3.4 mm, flattened, light-colored, mottled brown and black.

Widespread and seasonally common across the flora area, especially along washes and other drainageways, rocky slopes, and dunes.

Arizona below the Mogollon Rim to western Texas, Sonora southward to the Guaymas Region, and both Baja California states.

Nabhan (1985) reported the immature pods were eaten fresh and the dry seeds boiled and eaten like lentils.

Figure 34. *Phaseolus filiformis*. Alamo Canyon: (A) 10 Sep 2008; (B & C) 26 Feb 2014. (D) Diablo Canyon near Ajo Mountain Drive, 12 Sep 2013.

OP: Bates Well, 18 Nov 1939, *Harbison 26158*. Quitobaquito, 5 Mar 1940, *Peebles 14554A*. Alamo Canyon, 7 Oct 1951, *Parker 7747*. Dripping Springs, 15 Apr 1952, *Parker 7916*. Estes Canyon, 11 Apr 1978, *Bowers 1236*. Cherioni Wash, 5 mi N of Visitor Center, *Johnson 10 Nov 1983*.

CP: Agua Dulce Spring: 13 Apr 1964, *Niles 342*; *Simmons 13 Apr 1964* (CAB). Christmas Pass, 13 Apr 1992, *Harlan 254* (CAB). Pinta Sands, 15 Sep 1992, *Felger 92-780*.

Prosopis – Mesquite, screwbean; *mezquite*, *tornillo*

Hardwood trees and shrubs, generally armed with spines or thorns. Leaves twice pinnate; gradually winter deciduous, with 1 or 2 pairs of opposite pinnae, each with 4–24+ pairs of leaflets (Figure 35). Petiole with a circular (crateriform) nectar gland at the base of the lower pinnae; pulvini well developed at base of the pinnae and leaflets. Flowers mimosoid, small, cream white or yellow, in densely flowered spike-like racemes or spikes. Calyx shallowly toothed. Stamens 10 in 2 series and separate, the anthers with a small terminal gland. Flowers usually protogynous (the slender style protrudes from the bud before the stamens and petals emerge). Pods indehiscent, straight to curved or coiled, multiple seeded, indehiscent with carbohydrate-rich mesocarp.

Americas, Africa, and Asia; 44 species.

1. Leaflets 4–7 (10) pairs per pinna; flowers sessile, bright yellow, the petals united below; pods tightly coiled……..... sect. **Strombocarpa**, **Prosopis pubescens**, screwbean
1. Leaflets 9–24+ pairs per pinna; pedicels ca. 0.5 mm long, the flowers cream or dull yellow, the petals separate; pods straight or moderated curved but not coiled……..... sect. **Algarobia**, mesquites

2. Most leaves with a single pair of pinnae; leaves and twigs glabrous or hairy. ..... **Prosopis glandulosa**
2. At least some leaves with 2 pairs of pinnae; leaves and twigs hairy..... **Prosopis velutina**

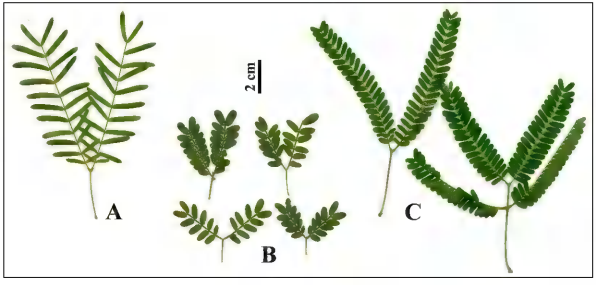

Figure 35. *Prosopis* leaves. Quitobaquito, 29 May 2015: (A) *P. glandulosa*. (B) *P. pubescens*. (C) *P. velutina*, Ajo, 4 Apr 2015.

Prosopis, sect. **Algarobia**. Mesquite

Two closely related mesquites are widespread across the flora area, honey mesquite in the west and velvet mesquite to the east. Mesquites are concentrated along the larger drainageways where the largest trees occur, and are also very common, mostly as large shrubs or small trees, along smaller drainageways, roadsides, at dirt tanks (charcos), and less common in other habitats including rocky slopes. The severe drought of the 2000s caused a dieback of mesquites, and many surviving trees lost many branches.

The fossil mesquite specimens do not allow us to determine which of the two species were gathered by Ice Age packrats. Mesquites have been in the flora area for at least 18,850 years. Mesquite in the Ajo Mountains seems to have been more common in the older samples than in the younger ones and there are some shifts in local distributions. It no longer grows near the rock shelter with the midden site in Alamo Canyon. The Puerto Blanco fossil site is a rocky slope and today velvet mesquite grows below the slope in the arroyo bed.

†**OP**: Alamo Canyon, leaflets, endocarps, 1150 to 9570 ybp (4 samples). Puerto Blanco Mts, on ridge, twigs, spines, leaflets, endocarps, 980 to 10,540 (7 samples).
†**TA**: Butler Mts, leaflets, 740 & 8160 ybp. Tinajas Altas, spines, leaflets, endocarps, 1230 to 18,700 ybp (14 samples).

Mesquite was the single most useful plant in the Sonoran Desert (Bell & Castetter 1937; Felger 1977, 2007a & b; Felger & Johnson, accepted for publication; Felger & Logan 2010; Felger & Moser 1985; Hodgson 2001). There are no known differences in usage between the two mesquite (*Algarobia*) species in the flora area. Every part of the tree was used (see Rea 1997 for an excellent, detailed account). Mesquite was the common denominator among the diverse indigenous people of the region—people who grew crops as well as hunters and gatherers who lived where it was too arid to farm. It was part of everyday life from cradle to grave and featured prominently in oral literature.

The pods were used for food and the wood as fuel. The largest mesquite groves, growing along major washes and watercourses, provided ample shade and places to camp and build homes.

Mesquite pods are large and easy to pick, either from the tree when ripe or from the ground soon after they fall. The pod is indehiscent (does not split apart) and thus the contents do not fall out. People knew the location of trees or groves that produced sweeter pods and superior yields. Ripe pods would be broken open and tasted for sweetness and ripeness. In addition, mesquite and screwbean pods were obtained from packrat nests, which allowed an extension of the harvest season. Harvested pods were sun-dried or fire-parched and laboriously crushed or ground into flour, often in a bedrock or stone mortar using a large pestle. There were numerous variations in the preparation of the pods and flour — mesquite "was a versatile staple" (Rea 1997: 187).

Mesquite and screwbean food products generally were prepared without cooking. The flour was most often steeped in water and consumed as a gruel (*atole de mesquite*) or made into cakes. Pods were also crushed and boiled or steeped in water as a beverage. Whole mesquite pods or cakes were stored — the flour was not stored because it is hygroscopic and soon becomes hard and undesirable.

"You can also grind the mesquite beans and make it into flour. There are many different ways to eat mesquite beans. You can also mix mesquite bean with roasted wheat flour" (Betty Melvin in Zepeda 1985: 49). "They would make a corral, my grandmother and my grandfather. . . . They would then gather mesquite beans . . . and they would fill up that corral. . . . When it was real sweet they would make gruel out of it. And they would grind it when they were dried. . . . It is very good. And they would buy some raw sugar in Sonoita and eat it with it" (p. 77). Sue Rutman observed Norma Quiroz de Walker make *atole de pechita*: she pounded the pods then simmered them in water and added sugar, cinnamon, and sometimes some cornstarch — Sue thought it was delicious. In addition, mesquite flowers were gently mashed in water and the sweet liquid drunk.

For the most part mesquite pods were available for harvest at the height of the early summer dry season. Lumholtz (1912: 331) reported that Hia-Ced O'odham "used to come as far as Quitovaquito and Santo Domingo to gather mezquite beans (called by the Mexicans *pechita*)." In modern times mesquite pods serve as fodder or forage for cattle. Many animals consume the pods, which are the primary seasonal food for coyotes. The pods are eaten within a few weeks of falling to the ground.

The whitish or amber-colored gum, oozing from wounds on the branches or trunk, was extensively employed for medicine (especially for eye ailments), eaten as candy, chewed as gum, or mixed with saguaro fruit and eaten like jam. The black sap or pitch collected from the bark was used as a general-purpose black dye as well as for many medicinal purposes.

Mesquite continues to be the preferred regional cooking fuel, not only because it is so readily available but also because of superior burning qualities and the flavor it imparts to food. House posts most often were made of mesquite trunks and the forked trunks or main branches were especially popular in local architecture. The roots were fashioned into multi-purpose cordage.

Most of the historic corrals in the region were made from mesquite, ironwood (*Olneya*), and railroad ties. During the late 19th and first half of the 20th centuries many Arizona and Sonora ranches used large quantities of mesquite logs for corrals, many of which were still standing in the late 20th and early 21st centuries. Stacked mesquite corrals were located at Aguajita, Bates Well, Daniels Well, Gachado line camp, and the Gray Ranch at Dos Lomitas (e.g., Bobby Gray, in Hoy 1970). Most of the mesquite logs at the Gray Ranch and Gachado corrals had been stolen by the

1990s (most of these corrals are on the international border, where there was essentially no fence there until 2004). Railroad ties were sometimes used as the upright supports for stacked mesquite logs.

The following discussion is excerpted and slightly modified from an essay by Felger (2007b):

> Along the east side of the Cabeza Prieta Refuge the mesquites are readily identified as the velvet mesquite (*Prosopis velutina*)—the common mesquite of the Arizona Upland around Tucson and elsewhere across Pima County. Continuing westward along the rough dirt road, after entering Yuma County on the Camino del Diablo you soon cross the Pinta Sands and the northern outlier of the Pinacate Lava Flow.
>
> In washes in and around the Pinacate Lava and Pinta Sands, a number of "western" desert or Lower Colorado Valley species have replaced the "eastern" or Arizona Upland species (Felger 2000; Rosen 2007; Shreve 1951). The washes are much more densely vegetated than the open, creosotebush desert flats, and the trinity of large legumes (ironwood, mesquite, and palo verde) is still present. But there are some subtle as well as not-so-subtle changes. The mesquites here have more beautiful leaves than the ones seen on the east side of the Refuge. The leaves of these mesquites have larger leaflets and seemingly brighter greener leaves with only one pair of pinnae like those of the western honey mesquite (*Prosopis glandulosa* var. *torreyana*). But the leaves and twigs have the small hairs characteristic of the velvet mesquite (*P. velutina*). Farther west, in the vicinity of the Colorado River and southward along the Sonora coast, the leaves are both hairless (glabrous) and once-pinnate—the two major key features of the honey mesquite.

Thus the Pinta Sands mesquites share features of the two supposedly different species. There are several possibilities: (1) The mesquites are confused, non-cooperative, and don't know that they have been classified; (2) the taxonomy is confused and does not accurately reflect the situation; or (3) it is difficult or indeed impossible to make a "perfect" linear classification system for an evolutionary continuum. Any botanist engaged in taxonomy has struggled with problems of this kind — the mesquites in the western part of the Refuge are indeed intermediate in character. In fact the area of transition, or the intermediate population, is quite large. Yet we need names in order to communicate about the different kinds of life. As biologists we strive to make the classification reflect evolutionary patterns as closely as possible. But a continuum sometimes does not slice up into discrete units — there are fuzzy boundaries.

Kearney and Peebles (1960) listed Arizona mesquites as varieties of *Prosopis juliflora*. Marshall Johnston (1962) of the University of Texas published a study of the North American mesquites in which the Arizona mesquites are quite differently classified — as *P. velutina* and *P. glandulosa* var. *torreyana*, and this system was followed by the great botanists Arturo Burkart (1976) of Argentina and Jerzy Rzedowski of Mexico and his wife Graciela Calderón (Rzedowski & Calderón 1988). But Lyman Benson, in his revision of *Trees and Shrubs of the Southwest* (Benson & Darrow 1981), continued to treat the Arizona mesquites as varieties of *P. juliflora*. The overwhelming evidence, however, shows that *P. juliflora* is a tropical species that does not reach the USA or even the Sonoran Desert.

Sect. *Algarobia* includes about two dozens species in South America and half a dozen species in North America. The North American taxa tend to be allopatric (occupying different geographic ranges) and in general are notorious in having indistinct ("fuzzy") species boundaries with often broad areas of populations with intermediate morphologies. These distributional patterns probably represent continuous (clinal) variation or even reticulate evolution and sometimes can confound attempts at realistic taxonomy (e.g., Bessega et al. 2000; Bessega et al. 2006; Burghardt & Esper

2007; Palacios 2006). Although some intermediate populations might be of hybrid origin rather than continuous (clinal) evolution, extensive observations indicate clinal variation to be common among native North American *Algarobia* (e.g., Felger 2000). An intriguing and radical taxonomy of native *Algarobia* species in Mexico, and by extension the U.S.–Mexico borderlands, is based on morphology (Palacios 2006) but is at odds with much of our experience and awaits confirmation with rigorous molecular/genetic studies.

Prosopis glandulosa Torrey var. **torreyana** (L.D. Benson) M.C. Johnston
[*P. juliflora* (Swartz) de Candolle var. *torreyana* L.D. Benson. *P. odorata* Torrey & Frémont (in part, sensu Palacios 2006)]
Western honey mesquite; *mezquite*; kui. Figures 35A & 36.

Trees and shrubs. Bark on old stems dark brown to charcoal gray, irregularly checkered to shredding; bark on mid-sized and small branches smooth, gray or greenish brown. Older stems often with oily, black, oozing, bacterial slime flux from wounds beneath the bark; younger stems sometimes exuding light-colored gum. Paired or sometimes single thorns (apparently modified branches) above leaves in axillary buds (short shoots), or sometimes absent or reduced from some or most stems, and especially prominent among juvenile and salt- or water-stressed plants; these thorns often 0.8–4 cm long, straight, rigid, and sharp, at first dark colored, becoming whitish. Twigs and leaves glabrous or hairy. Leaves appearing simultaneously in spring after the last freezing weather; the plants gradually deciduous in winter. Leaves with 1 pair of pinnae (jugate); leaflets (6) 11–24 pairs per pinna, individual leaflets about 5 times longer than wide, 4.5–31 × 1.3–6 (8) mm (the smaller measurements are from drought-stressed plants).

Flowers dull yellow; mass flowering April and May, and sporadically through early fall; pods mostly ripening in early summer and sporadically through fall. Inflorescences spike-like racemes, cylindrical, (4) 6–9 cm long, often several in a cluster. Flowers numerous, crowded, pale yellowish, 4.5–5 mm long, with pedicels ca. 0.5 mm long. Stamens longer than the petals; ovary and inner surface of petals densely white hairy. Pods straight to moderately curved, often (7) 10–20 cm × 7.5–10 mm, slightly compressed, often slightly to conspicuously constricted between some or most or all seeds; mesocarp sweet and well developed. Seeds encased in a tough, leathery endocarp drying hard and bony; cotyledons bright green even within the endocarp in the fruit. Pods pale tan to reddish and often mottled.

Western honey mesquite is characteristic of the Lower Colorado Desert region of the Sonoran Desert. It often has larger and more widely spaced leaflets than velvet mesquite. In the southwestern corner of Organ Pipe and nearby areas of Cabeza Prieta many of the mesquites appear intermediate between honey and velvet mesquite (*see* Felger 2000). Honey mesquite then extends westward across Cabeza Prieta and the Tinajas Altas Region. However, even in the Tinajas Altas Mountains, in Frontera Canyon, the honey mesquite has pubescence like that of velvet mesquite. Shrub-sized honey mesquites are abundant around the margins of Las Playas and other playas.

Var. *torreyana* primarily occurs from Baja California to southern California, western Arizona, and southwestern Utah, and then Sonora southward along the coastal fringe of the state to Guaymas, then inland, beyond the desert, through the thornscrub to northern Sinaloa, and then eastward and northward to the Chihuahuan Desert of southeastern Arizona, New Mexico, and nearby northern Mexico. East of the continental divide it is largely replaced by var. *glandulosa*.

Palacios (2006) restricts *Prosopis glandulosa* to Nuevo León and Zacatecas in northeastern Mexico and places much of the rest of the distribution in Mexico and by extension the range in the USA in *P. odorata* Torrey & Frémont.

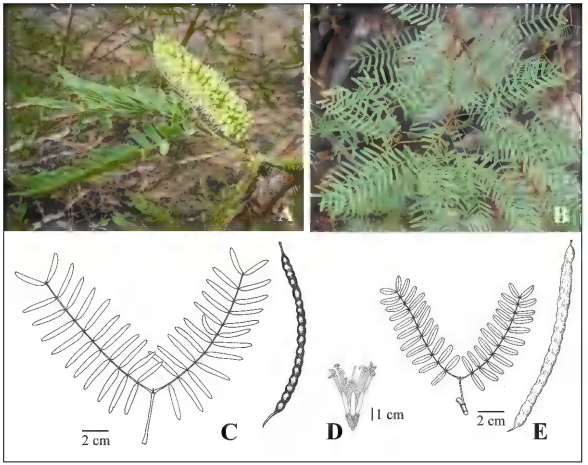

Figure 36. *Prosopis glandulosa* var. *torreyana*. (A) Near Blyth, Riverside Co., CA, 16 Apr 2002, photo by Keir Morse (CalPhotos). (B) Quitobaquito, 17 Jul 2013. Drawings by Matthew B. Johnson: (C & D) Tucson, Jul 2006; (E) Aguajita Spring, *Felger 88-28*.

CP: Salazaria Wash, 12 Apr 1992, *Harlan 213* (CAB). Camino del Diablo at boundary with OP, 1090 ft., 26 Mar 2010, *Felger 10-103* (ARIZ, ASU).

TA: Base of Tinajas Altas, 29 Mar 1930, *Harrison 6581*. Frontera Canyon, 18 Mar 1998, herbage pubescent, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-62*. Surveyors Tank, 29 Mar 2010, *Felger* (observation).

Prosopis velutina Wooton
[*P. juliflora* (Swartz) de Candolle var. *velutina* (Wooton) Sargent]
Velvet mesquite; *mezquite*; kui. Figures 35C, 37, & 38.

Large woody shrubs or trees. Similar to *P. glandulosa* var. *torreyana* but (1) the herbage and inflorescences pubescent, (2) at least some and usually most leaves bijugate (two pairs of pinnae; some new growth and drought-stressed leaves may be jugate), and (3) the leaflets proportionally broader, not attaining as large a size, usually more closely spaced, and tending to average more leaflets per pinnae. Leaflets about 3 times longer than wide, often 6–13 × 2–3.5 mm, 11–22+ leaflet pairs per pinna. As in *P. glandulosa*, flowering mostly April to June, and also sporadically through summer and early fall; pods mostly ripening in early summer and sporadically through summer and fall.

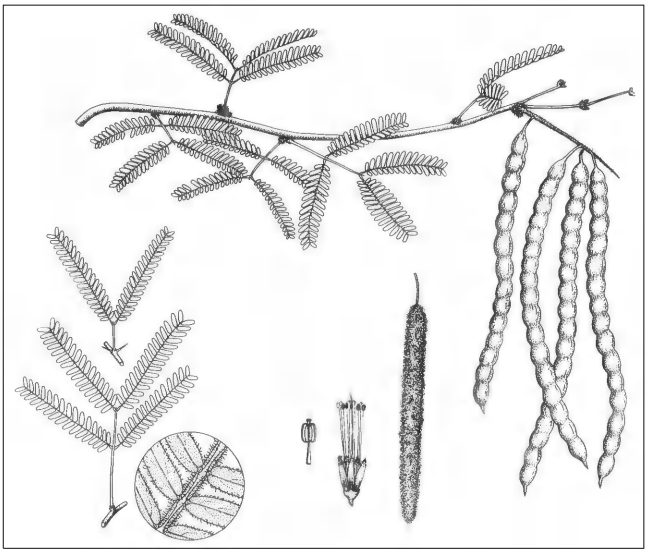

Figure 37. *Prosopis velutina.* By Matthew B. Johnson.

Eastern margins of Cabeza Prieta and across Organ Pipe. Common especially along washes and major drainageways, and scattered elsewhere including desert flats and rocky slopes. Mesquite forests grew near Armenta Ranch in Organ Pipe, but erosion and arroyo downcutting following overgrazing has killed these forests (Rutman 1995). In addition, innumerable mesquite trees were cut to supply the town of Ajo and the mines during the last decades of the 19th century and first few decades of the 20th century.

Velvet mesquite is characteristic of the Arizona Upland region of the Sonoran Desert. Widespread in Arizona, northern Sonora southward to the vicinity of Guaymas, and extreme southwestern New Mexico and northwestern Chihuahua.

OP: 8 mi S of Growler Well, *Nichol 17 Apr 1939*. Ridge between Alamo and Arch Canyons, *Fouts 8 Aug 1949* (ORPI). Aguajita, 23 Oct 1987, *Felger 87-270*. Quitobaquito, 14 Sep 1988, *Felger 88-451* (intermediate with *P. glandulosa* var. *torreyana*).

CP: Papago Well, 11 Apr 1978, *Lehto L-22487* (ASU). From Bates Well to Papago Well, 31 Jan 1992, *Felger* (observation).

Figure 38. *Prosopis velutina*. (A) Kuakatch Wash W of Hwy 85, 7 Oct 2006. (B) Hat Mountain, Sauceda Mts, Maricopa Co., 22 Mar 2014. Ajo: (C) 21 Jul 2014; (D) 14 May 2006; (F) 14 Jun 2013. (E) Between Why and Ajo, 4 Aug 2006.

Prosopis sect. **Strombocarpa**

Prosopis pubescens Bentham

[*Strombocarpa pubescens* (Bentham) A. Gray. *Prosopis odorata* Torrey & Frémont (not sensu Palacios 2006). *Strombocarpa odorata* (Torrey & Frémont) A. Gray]

Screwbean; *tornillo*; kujel. Figures 35B & 39.

Large shrubs or small trees to 6 m tall. Spines stipular, paired, straight, white, often stout, reaching 1–2.5 cm long. Leaves with one pair of pinnae (exceptionally 2); leaflets 4.5–13 mm long, 4–7 (10) pairs per pinna. Inflorescences of cylindrical spikes 3–4.5 cm long. Flowers sessile, the petals, sepals, filaments, anthers, and anther glands bright yellow. Stamens well exerted, the filaments with some reddish flecks. Style and ovary hidden by dense white hairs. Pods in clusters of (3) 6–20+; individual pods tightly coiled, cylindrical, (2) 3–4 cm × 4–5.5 mm—these coiled pods are unique among the flora of western North America. Flowering in May and sporadically through summer and fall; pods ripening during the summer months.

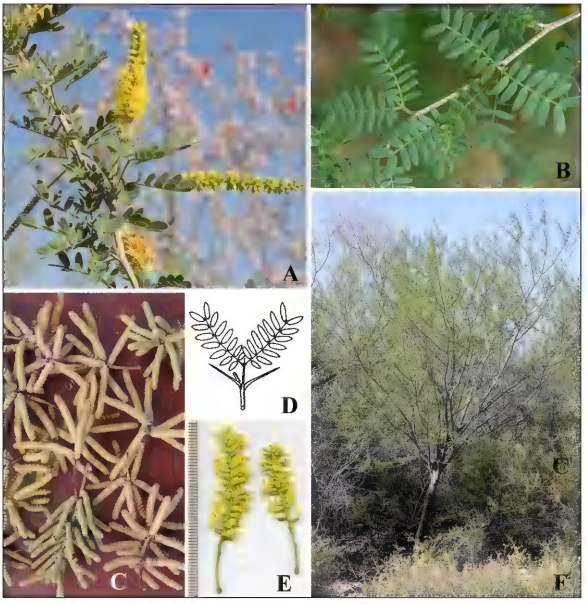

Figure 39. *Prosopis pubescens*. (A) Ajo, 14 May 2006. (B) Mesilla Bosque State Park, Doña Ana Co., NM, 16 Aug 2008, photo by Patrick Alexander. Quitobaquito: (C) 4 Aug 2006; (E) 23 Sep 2013; (F) 5 Apr 2013. (D) By Matthew B. Johnson.

Localized in wet soil and washes in the Quitobaquito region, and also recorded at Walls Well in 1939. The nearest populations are along the lower Gila and Colorado rivers.

Southern California to southwestern Utah, Arizona, Texas, northern Chihuahua, and northwestern Sonora.

The pulp (mesocarp) of the pods is sweet and served as a significant carbohydrate source. The pods were harvested in early summer, and parched, or often buried in a pit to "ripen" or partially ferment, and then ground into flour. The pods were also sometimes fermented as a beverage (Bell &

Castetter 1937; Castetter & Bell 1951). The wood was used for house construction and fuel, and perhaps weapons, and the roots and bark as medicine (Bell & Castetter 1937; Felger 2007a).

OP: Quitobaquito and vicinity: 28 Jan 1894, *Mearns 2738* (US, not seen); 14 Sep 1986, *Felger 86-327*; Near water channel, in and around spring, 23 May 1991, *Baker 8363*. Walls Well, *Nichol 28 Apr 1939*.

Psorothamnus

Shrubs or small trees, pubescent and with lens-like glands, especially on the stems. Leaves odd-pinnate or reduced and mostly leafless in *P. spinosus*. Flowers papilionoid, the petals pink or vivid blue or purple. Stamens 10, the filaments united. Ovules 2 to several; pods indehiscent, 1- or 2-seeded.

Deserts in southwestern USA and northern Mexico; 9 species. A genus segregated from *Dalea*.

1. Nearly leafless large shrubs or small trees, mostly more than 1.5 m tall; trunks and lower limbs with well-developed hardwood; twigs ending in sharp thorns; leafless or with few, quickly deciduous, simple (unifoliolate) leaves…….. **Psorothamnus spinosus**
1. Leafy shrubs seldom more than 1 m tall, scarcely woody at base, lacking well-developed hardwood; twigs not spinescent; leaves odd-pinnate.

2. Flowers sessile, in dense head-like (capitate) spikes; leaves with (3) 5–11 leaflets. ……..**Psorothamnus emoryi**
2. Flowers pedicelled, in racemes; leaves with 3 or 5 leaflets…… **Psorothamnus fremontii**

Psorothamnus emoryi (A. Gray) Rydberg var. **emoryi**
[*Dalea emoryi* A. Gray]
Emory's smokebush. Figure 40.

Densely branched shrubs probably less than 1 m tall. Herbage tomentose, grayish white with very dense tangled hairs obscuring the surfaces, and sparsely dotted with minute red-orange glands. Crushed herbage and flowers sweet smelling and imparting a fugitive yellow-orange stain. Leaves gradually drought deciduous, 1.8–4.5 cm long, odd-pinnate with (3) 5–11 leaflets, or sometimes reduced by 1 leaflet and even-pinnate on upper branches; leaflet margins entire or with rounded, shallow teeth; the paired leaflets 2–9 mm long, mostly obovate to spatulate, and blunt-tipped, the terminal leaflet (7) 12–32 mm long, linear to narrowly oblong. Flowers sessile, in short, head-like spikes; flowering following rains, spring and summer. Calyx 4.5–6.1 mm long, with oval, red-orange glands between the ribs. Corollas dark purple, longer than the calyx. Pods ca. 2.5 mm long, the seeds 1.5 mm long, smooth, brown.

In the flora area known only from dunes of the Pinta Sands and apparently not common. It is very common on sandy soils in adjacent northwestern Sonora and farther west in Arizona, as well as on the Mohawk Dunes (Felger et al. 2003).

Southwestern Arizona, northwestern Sonora, and southeastern California to Baja California Sur. Another variety occurs in Baja California Sur.

A fugitive yellow dye was made from the herbage by Cahuillas and Seris (Bean & Saubel 1972; Felger & Moser 1985).

CP: E Pinta Sands, 15 Sep 1992, *Felger 92-757* (ARIZ, NY). E side of Pinacate Lava flow and E Pinta Sands, low dunes encroaching lava field, seen only on higher [part of] dunes, 11 Apr 1993, *Felger 93-390* (ARIZ, ASU).

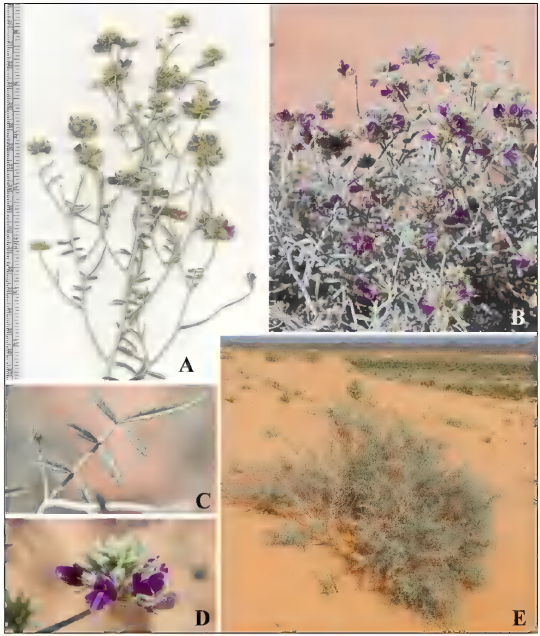

Figure 40. *Psorothamnus emoryi* var. *emoryi*. Dunes 22 mi SW of Sonoyta, E of Mex Hwy 8, Sonora: (A & B) 17 Mar 2014; (C) 19 Mar 2010; (D) 20 Feb 2014; (E) 6 Feb 2014.

Psorothamnus fremontii (Torrey ex A. Gray) Barneby
[*Dalea fremontii* Torrey ex A. Gray]
Frémont's dalea. Figure 41.

Shrubs less than 1 m tall, gland-dotted and generally pubescent (silvery strigose). Leaves odd-pinnate with 3–7 (9) leaflets, and leafless or essentially so in drought. Inflorescence a raceme, the flowers 7–9.5 mm long, and bright violet-purple. Pods indehiscent, 1-seeded, 7–10 mm long,

with small glands forming longitudinal lines. [Description based on plants from farther north in Arizona and the Jepson Flora Project (2012)].

Figure 41. *Psorothamnus fremontii*. (A) By Lucretia Breazeale Hamilton. (B) Near 1000 Palms Reserve, Riverside Co., CA, 5 Mar 2004, photo by Brent Miller (CalPhotos). (C) 18 mi N of La Paz County line, Mohave Co., *Richardson 11 Apr 2003* (ASU).

A single shrub of this species was found at the north end of the Sierra de la Lechuguilla at the south end of the Lechuguilla Valley. Frémont's dalea is common farther north with four disjunct southern records: this one, one near the Colorado River in southeastern California collected in 1969, one in Yuma collected in 1905, and one from Puerto Peñasco in northwestern Sonora (Felger 2000; SEINet 2015). This species occurs in the Sonoran and Mohave deserts in Arizona, California, Nevada, Utah, Sonora, and Baja California.

The single specimen from the flora area was collected during a dry season—there were a few buds and no flowers. Two varieties are described: var. *fremontii* generally grows on sedimentary rocks, while var. *attenuatus* Barneby is on granitic and volcanic rocks (Turner et al. 1995). *Psorothamnus fremontii*, however, may not be distinct from *P. arborescens* (Torrey ex A. Gray)

Barneby, both of which have somewhat similar distributions primarily north of the Sonoran Desert in dry regions of Arizona, California, Colorado, and Nevada (Barneby 1977; Turner et al. 1995).

TA: Rounded hills along La Jolla Wash, between the Sierra de la Lechuguilla and the Tinajas Altas, UTM 2 18 915 E, 35 73 341 N, WGS 84, 1050 ft, shrub about 0.8 m tall, uncommon, with *Larrea*, *Ambrosia dumosa*, *Fagonia californica*, & *Parkinsonia microphylla*; *Sundt, MacKinnon, & Malusa 2 Apr 2011*.

Psorothamnus spinosus (A. Gray) Barneby
[*Dalea spinosa* A. Gray. *Psorodendron spinosum* (A. Gray) Rydberg]
Smoke tree; *palo cenizo*. Figure 42.

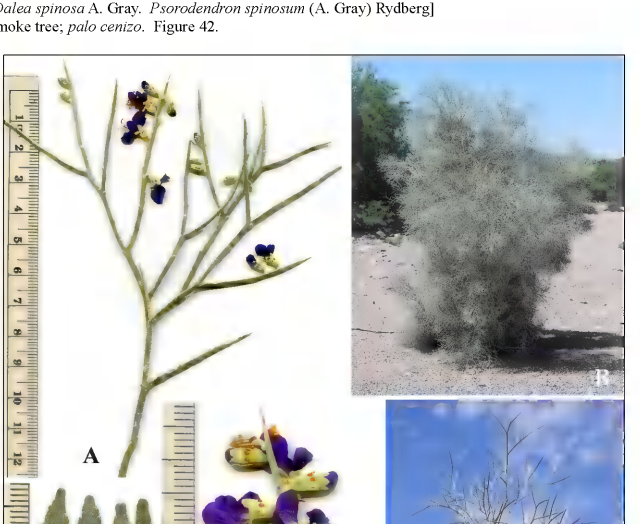

Figure 42. *Psorothamnus spinosus*. (A & D) Drainage about 25 miles S of Sonoyta on Hwy 8, 17 May 2015. (B & E) Aguajita Wash near El Papalote, Sonora, 5 Sep 2013. (C) Aguajita Wash at El Papalote, 2 Aug 2014.

Unique hardwood large shrubs or small trees 3–6 m tall; trunks or major limbs often several, often moderately irregular and twisted, sometimes reaching 22–35 cm diameter; bark smooth and gray, with age the trunk often somewhat fissured and rough. New growth appearing during hot weather. Upper and smaller stems much-branched, the twigs silvery to bluish gray, thorn-tipped and

painful to handle (perhaps due to mild toxins). Twigs, pedicels, and calyces densely hairy with short, appressed, white hairs; twigs, inflorescence branches, calyces, and pods bearing bright orange glands. Essentially leafless, the leaves very sparse, present on fresh young growth, quickly deciduous, reduced to 1 leaflet often 5–25 mm long, oblanceolate, bluish gray, thick and almost succulent, dotted with orange glands. (This leaflet is analogous to the enlarged terminal leaflet of other *Psorothamnus* species.) Seedlings and young plants with leaves reaching 20–65 mm long and usually leafier than new growth of adult plants. Flowers brilliant blue-purple (indigo), produced in spectacular masses during the hottest, driest time of year — May and June. Inflorescences of few-flowered, spinescent, twig-like racemes; individual flowers 12 mm long. Calyx 4.5–5 mm long, the tube prominently ribbed with several large orange-brown blister glands around the middle, the lobes reflexed with age. Corollas deep indigo-blue. Pods often 5–5.5 mm long with several orange-brown blister glands around the middle, and a tail-like persistent style; 1(2?)-seeded, the seeds 4–4.3 mm long, oblong-ovoid, smooth, brown, and mottled.

Large gravelly washes such as ones leading out of the Cabeza Prieta and Tule mountains, and in the Mohawk Valley in Cabeza Prieta, and scattered along Aguajita Wash in Organ Pipe. A number of smoke trees at Aguajita Wash were killed by a scouring flood in 2012. Smoke trees are much more common in nearby areas.

Southwestern Arizona, southeastern California, southern Nevada, east side of Baja California, and northwestern Sonora.

OP: Quitobaquito, *Nichol 3 Mar 1939*. 3 mi E of Quitobaquito, large wash, 24 Oct 1965, *Lehto 5488* (ASU). Aguajita, *Wirt 12 Apr 1989* (ORPI).
CP: Smoke-tree Wash, Cabeza Prieta Mts (Simmons 1966). Drift Hills, 0.5 mi W of Senita Tank, 1070 ft, large wash, 14 Jun 1992, *Felger 92-595*. Mohawk Wash, W of Bean Pass, Sierra Pinta, *Rutman 17 Feb 2002*.

Rhynchosia – Rosary bean

Herbaceous perennials, vines, and shrubs. Flowers papilionoid. Worldwide, mostly tropics and subtropics; 230 species. The colored seeds, including bicolored black and red seeds, are used as necklaces and other decorations.

Rhynchosia texana Torrey & A. Gray
[*R. senna* Gillies ex Hooker & Arnott var. *texana* (Torrey & A. Gray) M.C. Johnston. *R. texana* var. *angustifolia* (A. Gray) Grear]
Texas snout-bean. Figure 43.

Perennial vines; pubescent and glandular. Leaflets 3, dark green, ovate, or ovate-lanceolate to linear, with prominent veins, and small, round golden glands dotting the lower surfaces, the margins minutely ciliate. Flowers solitary or in pairs on pedicels to 6 mm long, the corollas 5–7 mm long, bright yellow-orange. Stamens 10; 9 fused, 1 free. Pods 2-seeded and dehiscent. Reproductive during the warmer months.

In the flora area restricted to the Ajo Mountains in canyons and at the upper limits of the desert.

Arizona, mostly southeastern and central, to Texas and Mexico and disjunct in South America (Ecuador to Argentina).

OP: Bull Pasture, 9 May 1979, *Bowers 1710* (ORPI). Alamo Canyon: N fork, 700 m, 17 Oct 1987, *Baker 7552* (ORPI); Above the waterfall, 2470 ft, 17 Oct 2013, *Rutman 20131017-3*. Tributary canyon to Arch Canyon, shaded protected niche, *Rutman 16 Sep 2006*.

Figure 43. *Rhynchosia texana*. (A) Bull Pasture Trail, 21 Sep 2008. (B) Vicinity of Visitor Center, Chiricahua National Monument, Cochise Co., *Reeves R-3551* (ASU). (C) Piños Altos, Piños Altos Range, Grant Co., NM, 25 Jul 2009, photo by Russ Kleinman (gilaflora.com). (D) Alamo Canyon, 9 Sep 2014.

Senegalia

Trees and shrubs. Flowers mimosoid. Tropics to deserts, nearly worldwide; 200 species. A genus segregated from *Acacia*.

Senegalia greggii (A. Gray) Britton & Rose
[*Acacia greggii* A. Gray. *A. greggii* var. *arizonica* Isely]
Catclaw; *uña de gato, gatuño*; 'u:pad. Figure 44.

Large, irregularly branched shrubs with crooked trunks and branches, often 2–5 (6) m tall; wood strong and hard, the heartwood reddish. At least some stems armed with catclaw-like solitary prickles between or just below the nodes, these curved downward, and tapering to sharp point. Young twigs, leaves, and inflorescences moderately to densely pubescent with short hairs. Leaves gradually winter deciduous, twice pinnate, often 2.5–3.5 cm long, the pinnae 1 or 3 pairs; leaflets 3.5–6 (8) mm long, 4–6 (7) pairs per pinna; petioles with a prominent nectary gland. Inflorescences of dense, cylindrical, spike-like racemes, often 1.8–3 cm long, the peduncle often 1–2.5+ cm long. Flowers fragrant, pale yellowish, at first sessile or nearly so, becoming very short-pedicelled. Calyx shallowly lobed. Stamens numerous and separate, the anthers very small, sometimes with a terminal gland. Pods (3.5) 6–15.5 × 1–1.6 (2+) cm, conspicuously flattened, ribbon-like, more than twice as wide as

thick, usually curved or curled, sometimes moderately constricted between some seeds, and indehiscent or tardily semi-dehiscent (the whole pod usually falls and is chewed by rodents). Seeds oval to orbicular, conspicuously flattened, dark brown, 10.3–12.7 × 3.4–3.9 mm. Mostly flowering in spring, the pods ripening in June.

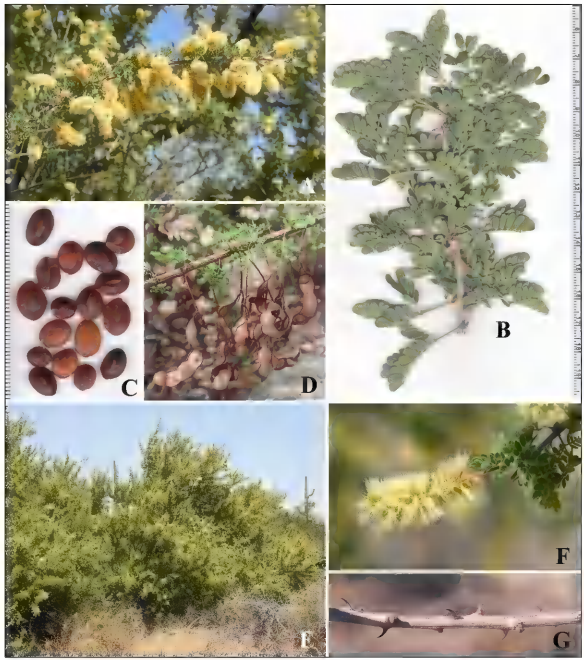

Figure 44. *Senegalia greggii*. Ajo: (A & F) 6 May 2006; (B & E) 23 May 2010; (C) 13 Sep 2008. (D) Diablo Mts, Ajo Mountain Drive, 2 Aug 2013. (G) Kuakatch Wash near Hwy 85, 13 Mar 2010.

Widespread across the flora area, in larger washes and arroyos, less often along smaller drainageways, and hills and slopes, especially north-facing. Often dominant along valley floor

washes. Large catclaw trees occur along Cuerda de Leña in Organ Pipe. Catclaw is one of the favorite foods of desert bighorn. It extended across the region during the Ice Ages and has been in the Tinajas Altas Region for at least 37,000 years.

Deserts across northern Mexico, and western Texas to southwestern Utah and southeastern California.

Isely (1969, 1998) segregated populations west of Texas as var. *arizonica*, characterized by densely hairy leaves. "However, since glabrous individuals occur as far west as Baja California, and the leaflets of part of Gregg's original gathering are puberulent, a taxonomic distinction is difficult to sustain" (Barneby 1989: 7).

The seeds were parched and ground, or the pods pounded, and the flour consumed as a gruel or made into cakes (Castetter 1935; Russell 1908). These foods, however, were sometimes bitter and not esteemed (Bean & Saubel 1972). The Gila River Pimas drank tea from the root for stomach ulcers and more recently to alleviate kidney problems caused by alcohol consumption (Rea 1997). The hard, reddish wood served many purposes, including bows, crosspieces of saguaro fruit–gathering poles, prayer sticks with eagle feathers, and firewood, and the flexible branches were used for cradleboard frames (Bean & Saubel 1972; Castetter & Underhill 1935; Felger & Moser 1985; Rea 1997).

OP: Cipriano Well, *Nichol 27 Apr 1939*. Alamo Canyon, 19 Apr 1942, *Cooper 564*. Aguajita, 19 Jun 1989, *Felger 89-238*. †Alamo Canyon, spines (prickles), leaflets, 1150 to 14,500 ybp (4 samples).

CP: Lower Well (Simmons 1966). Little Tule Well, 12 Jun 1992, *Felger 92-537*. Vicinity of Papago Well, 26 Mar 2010, *Felger 10-129*. Junction of Camino del Diablo and road to Cabeza Prieta Tanks, 32°13'13.6"N, 113°48'04.9"W, 360 m, 28 Mar 2010, *Felger 10-156*. *Felger*, observations: Charlie Bell Rd, 0.4 mi W of E Refuge Boundary, 31 Jan 1992; Daniels Wash at Charlie Bell Road crossing, 18 Aug 1992; Agua Dulce Pass, Jose Juan Represo, Heart Tank, 3.5 mi NE of Tule Well on road from Christmas Pass in the Drift Hills, Cabeza Prieta Tanks, Half-way Tank, Buck Mt. Tank, 12–15 Jun 1992.

TA: Tinajas Altas, 19 Mar 1998, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-21*. †Butler Mts, stem prickles, leaflets, fruits fragments, 740 to 8160 ybp (3 samples). †Tinajas Altas, twigs (prickles), leaves, 1230 to 11,040, & >37,000 (14 samples).

Senna

Herbaceous perennials to trees. Flowers caesalpinioid. Tropics, warm temperate regions, and deserts, nearly worldwide; 300–350 species. A genus segregated from *Cassia*.

Senna covesii (A. Gray) H.S. Irwin & Barneby
[*Cassia covesii* A. Gray]
Desert senna; *hojasén*, *daisillo*; ko'ovï ta:tamï. Figure 45.

Perennials from a semi-woody base, probably not long-lived; dormant during cooler and drier months. Stems mostly erect, dying back in drought; herbage densely white-velvety hairy. Leaves drought deciduous, even-pinnate, the leafstalk with a long-stalked, orange nectary gland between the leaflets of each pair; leaflets (2) 3 (4) pairs, elliptic to elliptic-oblong, the larger ones 1.5–2.8 (3.5) cm long. Flowers 1.5–2 cm wide, yellow-gold, becoming pale yellow or whitish with age. Fertile stamens 7, the filaments shorter than to about as long as the anthers, the anthers orange-brown, opening by terminal pores (the flowers are buzz-pollinated by bees); sterile stamens 3, shorter than the fertile stamens. Pods 2.2–3.5+ cm long, several seeded, splitting along both sutures, with dense, short, appressed to spreading hairs. Flowering response non-seasonal during warmer weather.

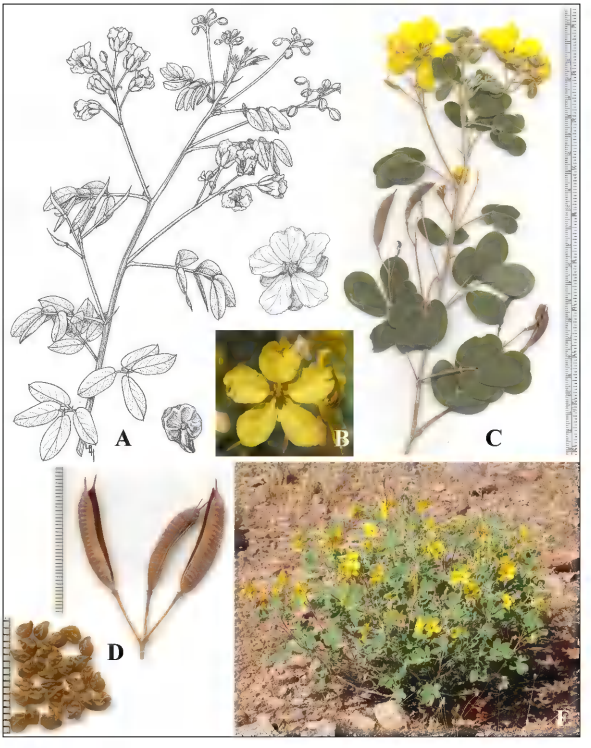

Figure 45. *Senna covesii*. (A) By Lucretia Breazeale Hamilton. Copper Mountain: (B) 7 Aug 2005; (E) 7 Aug 2005. (C) Alamo Wash near Hwy 85, Aug 2008. (D) Arch Canyon trailhead, 12 Sep 2014.

Widespread across much of the flora area but not extending to the Tinajas Altas Region. Often localized; various habitats including washes, sand flats, dunes, and rocky slopes. Often in

disturbed habitats such as roadsides, old rodent mounds, and scoured wash beds. It was in the Puerto Blanco Mountains about 2000 years ago.

Arizona, southern California, Nevada, southwestern New Mexico, Sonora, Sinaloa, and Baja California.

OP: Alamo Canyon, *Nichol 4 May 1939*. Bates Well, 23 Apr 1942, *Garth 562*. 16 mi N of Lukeville, 26 Sep 1964, *Felger 10530*. Puerto Blanco Drive, 5.2 mi W of Visitor Center, 16 Oct 1977, *Bowers 885*. †Puerto Blanco Mts, on ridge, seeds, 1910 ybp.

CP: Childs Mountain, 2300 ft, 18 Aug 1992, *Felger 92-645* (ARIZ, ASU). E Pinta Sands, 15 Sep 1992, *Felger 92-764* (ARIZ, ASU). Senita Tank Wash, 14 Apr 1992, *Harlan 280* (CAB). Charlie Bell Road 1.9 km NE of Little Tule Well, 5 Mar 1994, *Felger 94-28*.

Tephrosia

Herbaceous perennials and shrubs, rarely annuals. Flowers papilionoid. Worldwide, mostly tropics and subtropics; 400 species.

Tephrosia tenella A. Gray

Red hoary-pea. Figure 46.

Herbaceous perennials. Herbage sparsely pubescent or essentially glabrous. Leaves odd-pinnate, to ca. 10 cm long; leaflets pale green, 5–11, potentially 1.5–3.5 cm long, linear to narrowly oblong or elliptic; stipules 5–8 mm long. Flowers pink, drying wine colored, less than 8 mm long. Stamens 9 united, 1 free. Pods 3–4 cm long, multiple-seeded, elastically dehiscent, the valves coiling.

Figure 46. *Tephrosia tenella*. (A & B) N end of Salero Ranch, Santa Cruz Co., 23 Sep 2013, photos by Sue Carnahan. (C) Cracks in bedrock, upper elevations of middle fork of Alamo Canyon, *Rutman 5 Sep 1999*.

Ajo Mountains, known from a single record, although probably more widespread at higher elevations.

Southern Arizona to Texas, and Mexico to Central America. These plants have been treated as *Tephrosia vicioides* Schlechtendal, but Téllez (2001) showed that *T. vicioides* is a different species that Nesom (accepted for publication & in press) restricts to Veracruz and Oaxaca.

OP: Ajo Mts, upper elevation of the headwaters of the middle fork of Alamo Canyon, in cracks in bedrock, potential habitat is extensive but unsurveyed, *Rutman 5 Sep 1999* (ARIZ, ORPI).

Trifolium

Annuals and herbaceous perennials. Flowers papilionoid. Nearly worldwide, 300 species.

Trifolium wormskioldii Lehmann

[*T. wormskioldii* var. *arizonicum* (Greene) Barneby. *T. lacerum* Greene. *T. willdenovii* Sprengel]

Cow clover. Figure 47.

Spring-flowering ephemerals, glabrous. Leaflets 3, 1–3 cm long, elliptic to ovate, the margins serrate-toothed. Stipules rather large, spinescent on lower leaves, broader on upper leaves. Flowers in head-like clusters subtended by spinescent bracts. Calyx lobes bristle-tipped. Corollas lavender, 12–15 mm long. Stamens 10; 9 fused, 1 free. Pods ca. 3.5–5 mm long, 1–3-seeded.

Figure 47. *Trifolium wormskioldii*. Alamo Canyon: (A) 22 Jul 2014; (B & C) 11 Mar 2014.

Ajo and Diablo mountains; often locally abundant in riparian canyon bottoms and especially open, rocky areas at higher elevations where it may grow hidden among grasses.

Although the Ajo Mountains plants are cool-season ephemerals, this species is generally perennial over most of its range. British Columbia to Baja California and east to Idaho, and southward to central Mexico.

OP: Alamo Canyon: *Nichol 14 Mar 1939* (ORPI); 2800 ft, N-facing slope, 12 Apr 1978, *Bowers 1243*; Canyon bottom, among dense growth of annuals, 29 Mar 2003, *Felger 03-405* (ARIZ, ASU). Ajo Mts, summit, 1 Apr 1944, *Clark 11549* (ORPI). Canyon Diablo, *Supernaugh 5 May 1949* (ORPI). Bull Pasture, 3300 ft, 5 Apr 1978, *Bowers 1205* (ORPI). Abundant near the crestline of the Ajo Mts, middle fork of Alamo Canyon, 15 Mar 2003, *Rutman 2003-357*.

Vachellia

Trees and shrubs; flowers mimosoid. Mostly tropics, subtropics, and deserts, nearly worldwide; 160 species. A genus segregated from *Acacia*.

1. Pods reddish or brownish, slender and dehiscent, 4–6 mm wide; common and widespread in the flora area..... **Vachellia constricta**
1. Pods dark brown to blackish when ripe, thick and tardily or not dehiscent, 8–10 mm wide; rare in the flora area..... **Vachellia farnesiana**

Vachellia constricta (Bentham) Seigler & Ebinger
[*Acacia constricta* Bentham]
White-thorn acacia; *mezquitillo*; gidag. Figure 48.

Shrubs to 4 m tall, with mostly straight branches. Bark of small- to mid-sized branches smooth and reddish brown. Spines at nodes (stipular), the larger ones 1–3 cm long, paired, straight, terete, and usually white, or some stems without spines. Herbage at first viscid with dot-like glands and sparsely to moderately pubescent with small white hairs, and becoming glabrate with age. Foliage gradually winter and/or drought deciduous, new leaves mostly appearing in mid-spring and with summer rains. Leaves (1.5) 3.5–4 cm long, the pinnae mostly 3–6 pairs (elsewhere sometimes 7 or 8 pairs), the leaflets 1.5–3 mm long; petioles bearing a prominent nectary gland. Flowers bright yellow and noticeably fragrant, in rounded heads ca. 1 cm wide. Pods slender, 4.5–13.5 cm × 4–6 mm, constricted between each seed, and gradually dehiscent.

Young pods reddish, sometimes bright red or green, glistening sticky-viscid, and spotted with small, dot-like raised glands, these range from colorless to golden to dark brownish-purple. This viscid exudate, probably derived from the glands, is water soluble. Mature pods become dull brown, no longer viscid, and the glands fewer or mostly no longer visible—however, look closely with magnification and you will see dot-like depressions in place of the glands. Similar glands are seen on the youngest herbage including newly forming spines, and these glands likewise leave depressions on slightly older stems. Seeds 4.5–5.2 mm long, mottled, moderately compressed, and somewhat oblong; seeds in freshly opened pods (ones that open naturally) have a glossy-resinous coating; exposed to the air they become dull (not glossy). Flowering mostly in spring, the pods ripe in June and July, and also flowering later in summer, depending on rainfall, and producing pods in fall.

Widespread in washes, canyons, rocky hills, and lower mountains, and extending into valleys on coarse, well-drained soils; across Organ Pipe and Cabeza Prieta except the western portion. It grew in the Ajo Mountains 1200 years ago.

Arizona to Texas and much of arid and semi-arid Mexico to Puebla and Oaxaca.

OP: Cipriano Well, *Nichol 27 Apr 1939*. Ajo Mt Drive, 9 mi by road NE of Visitor Center, 5 Nov 1977, *Bowers 928*. 5.8 mi E of Lukeville, 11 Nov 1987, *Felger 87-331*. S Puerto Blanco Drive, 2.4 mi W of Hwy 85, 19 Jun 1989, *Felger 89-222*. †Alamo Canyon, spines, 1150 ybp.

CP: Adobe Windmill (Simmons 1966). Camino del Diablo, SW of O'Neill Hills, 13 Mar 1993, *Harlan 360* (CAB). Charlie Bell Rd, 1 km W of E boundary of Refuge, 5 Mar 1994, *Felger 94-23*.

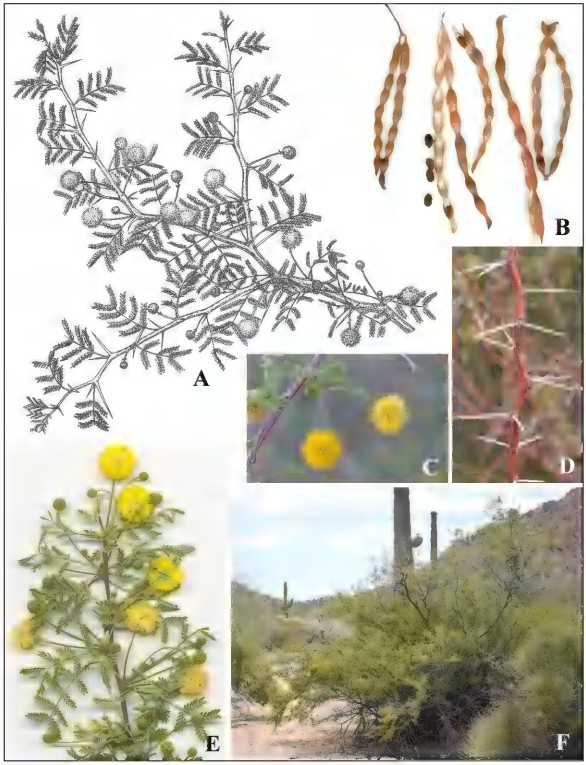

Figure 48. *Vachellia constricta*. (A) By Lucretia Breazeale Hamilton. Ajo: (B) 10 Sep 2006; (C) 21 May 2006; (E) 15 Sep 2008. (D) Near Valentine Tank, S of Ajo, 4 Mar 2009. (F) Senita Basin, 10 May 2010.

****Vachellia farnesiana** (Linnaeus) Wight & Arnott
[*Mimosa farnesiana* Linnaeus. *Acacia farnesiana* (Linnaeus) Willdenow. *A. smallii* Isely]
Sweet acacia; *huizache, vinorama.* Figure 49.

Generally called *vinorama* in Sonora and *huizache* elsewhere in Mexico. Shrubs to small trees; pubescent, the leaves becoming sparsely hairy with age. Spines reaching 2–4.5 cm, stipular, paired, white, straight, and terete. Leaves tardily drought deciduous and partially to fully winter deciduous. Leaves 2.5–5.5 cm long, the pinnae 2–6 pairs, the leaflets many, 3–7 mm long; petiole or rachis sometimes with a dark nectary gland. Flowers bright yellow-orange, in globose heads, with a strong and far-reaching sweet fragrance. Pods 4–7.5 cm × 0.8–1 cm, indehiscent to tardily dehiscent, dark brown to blackish, thick and not constricted between the seeds, with pulpy mesocarp, the seeds crowded in two rows. Young pods have sweet, pulpy mesocarp, which shrinks as the pods mature or age.

Vachellia farnesiana may be difficult to distinguish from *V. constricta* if pods are not available: *V. farnesiana* herbage lacks the golden glands usually seen on *V. constricta*, and in cultivation *V. farnesiana* is more robust and with larger leaves.

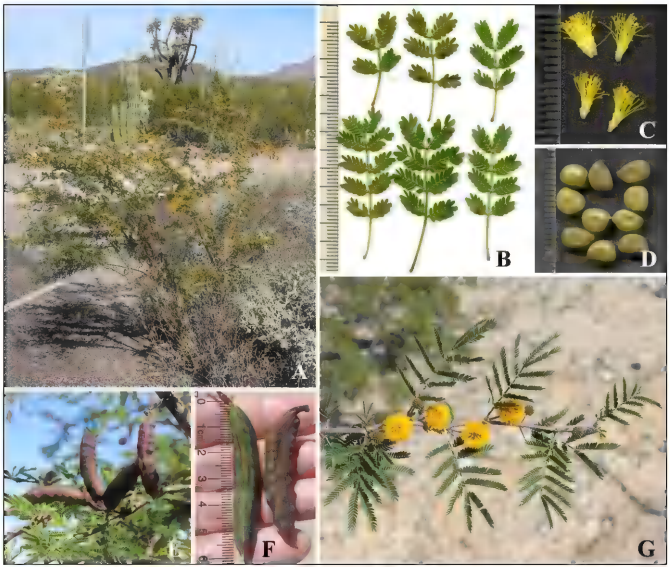

Figure 49. *Vachellia farnesiana.* (A & G) Intersection of Hwy 85 and Ajo Mountain Drive, 30 Jan 2014. Ajo: (B) 16 Jun 2015; (C–E) Ajo, 16 May 2015. (F) Pods from the Organ Pipe plant (left) and from cultivated plant in Ajo (right), 16 May 2015.

Three varieties of *Vachellia farnesiana* are recognized (Ebinger et al. 2002). Var. *farnesiana* is native in the Baboquivari Mountains in Arizona. This variety is extensively cultivated in southern Arizona and has become established in many areas in the state outside of cultivation; all or most Arizona plants are this variety. It is distinguished in part by having pods less than 10 cm long and seeds in 2 rows or irregularly arranged. Var. *minuta* (M.E. Jones) Siegler & Ebinger has pods 10 or more cm long and seeds in seeds in one row. Sweet acacias sampled in Ajo have pods less than 10 cm long and seeds in 2 rows. Several pods from the single sweet acacia shrub in Organ Pipe were 5–6 cm long but with seeds in a single row.

Var. *farnesiana* ranges from southern USA to South America and the West Indies. It is cultivated, naturalized, and/or weedy in many warm regions worldwide. An essential oil from the flowers has been an important ingredient in perfumes. Var. *minuta* occurs from southwestern California through the Baja California Peninsula and might be found in cultivation or feral elsewhere. Var. *pinetorum* occurs in Florida.

OP: Intersection of Hwy 85 and Ajo Mt Drive, single roadside waif, about 2 m tall, *Rutman 30 Jan 2014*.

CP: Ajo, Cabeza Prieta headquarters, planted, not given supplemental water, 1 Jan 2015, *Rutman*, observation.

Vicia – Vetch

Annuals and herbaceous perennials. Flowers papilionoid. Nearly worldwide; 160 species.

Vicia ludoviciana Nuttall ex Torrey & A. Gray subsp. **ludoviciana**

[*V. exigua* Nuttall]

Deer-pea vetch. Figure 50.

Delicate winter-spring annuals, the stems sprawling or climbing; pubescent or perhaps glabrate or glabrous. Leaves once pinnate, the leafstalk (rachis) ending in an unbranched or branched tendril, this sometimes branched (figure 50A); leaflets 4–12, linear to narrowly elliptic; stipules small. Corollas blue, 5–7 mm long. Flowering March to May. Pods 1.5–2.5 cm long, several-seeded, and dehiscent. This is the only legume in the flora area with tendrils.

Arizona Upland mountains in Organ Pipe including the Ajo, Bates, Diablo, and Santa Rosa mountains, often along canyon bottoms.

This subspecies from California to southeastern USA and northern Mexico; another subspecies occurs in Texas, southeastern USA, and northeastern Mexico.

OP: Alamo Canyon, 19 Apr 1942, *Cooper 578*. Alamo Wash, canyon outwash, 11 Sep 1946, *Haskell 1091* (UCR, det. Andrew C. Sanders 1988). Bull Pasture trail, 11 Apr 1978, *Bowers 1233*. Middle fork Alamo Canyon near crestline of Ajo Mts, 15 Mar 2003, *Rutman 2003-330* (ORPI). Alamo Canyon, 2408 ft, canyon bottom, in shade among dense growth of annuals, 29 Mar 2003, *Felger 03-403* (ASU, ARIZ). Foothills of Santa Rosa Mts, W of Diaz Peak, 2 Apr 2003, *Rutman 2003-447* (ORPI). Canyon, NW of Kino Peak, 2000 ft, 20 Mar 2005, *Rutman 2005-0320-29* (ORPI).

ACKNOWLEDGEMENTS

In addition to the acknowledgments provided in part three of this flora series (Felger et al. 2013b), we especially thank George Ferguson, Walter Fertig, Matthew B. Johnson, Richard (Rick) Alan Johnson, Kirsten Nicole Lake, Guy L. Nesom, Andrew M. Salywon, Andrew C. Sanders, and James (Jim) Thomas Verrier for information and review, Susan Davis Carnahan for expert copyediting and information, and Patrick Alexander, Susan Carnahan, Jilian Cowles, Russ Kleinman, John MacDonald, Brent Miller, Jean Pawek, and Keir Morse for photos.

Figure 50. *Vicia ludoviciana* subsp. *ludoviciana*. Alamo Canyon: (A, C & D) 4 Apr 2015; (B) 2 Mar 2008. (E) Estes Canyon, 18 Mar 2005.

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 15. EUDICOTS: FAGACEAE TO LYTHRACEAE

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ABSTRACT

A floristic and natural history account is provided for 11 eudicot families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the heart of the Sonoran Desert in southwestern Arizona: Fagaceae, Fouquieriaceae, Gentianaceae, Geraniaceae, Grossulariaceae, Koeberliniaceae, Krameriaceae, Lamiaceae, Linaceae, Loasaceae, and Lythraceae.

This is the fifteenth installment of our flora in southwestern Arizona and includes 11 eudicot families: Fagaceae (1 species), Fouquieriaceae (1 species); Grossulariaceae (1 species); Koeberliniaceae (1 species); Linaceae (1 species); Lythraceae (1 species); Krameriaceae (1 genus, 2 species); Gentianaceae (2 genera, 2 species); Geraniaceae (2 genera, 3 species); Loasaceae (3 genera, 9 species), and Lamiaceae (8 genera, 13 species) (Table 1). The flora area covers 5141 km^2 (1985 mi^2) of contiguous protected areas in the heart of the Sonoran Desert (Figure 1). This publication is also available open access on the website of the University of Arizona Herbarium (https://ag.arizona.edu/herbarium).

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. Explanation of the format for the flora series is provided in part 3 (Felger et al. 2013b). Family designations follow APG III (Angiosperm Phylogeny Group 2009) and the Angiosperm Phylogeny Website (Stevens 2012). *Erodium cicutarium* and *Limum bienne*, non-native taxa established in the flora area, are marked with an asterisk (*) and two non-natives not established in the flora area, *Salvia reflexa* and *Punica granatum*, are marked with double asterisks (**). Fossil specimens are indicated with a dagger symbol (†) and fossil specimens of the one species no longer present in the flora area (*Salvia mohavensis*) are marked with two dagger symbols (††).

All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Thiers 2014). All photos and scans are by Sue Rutman unless otherwise stated and botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986) unless otherwise stated. Descriptions and keys pertain to taxa and populations as they occur in the flora area.

Table 1. Local distributions and growth forms of Fagaceae, Fouquieriaceae, Gentianaceae, Geraniaceae Grossulariaceae, Koeberliniaceae, Krameriaceae, Lamiaceae, Linaceae, Loasaceae, and Lythraceae. † = Modern species and fossil specimen(s); †† = fossil no longer present; * = non-native species established in the flora area; ** = non-native species not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = Summer/warm-season ephemerals; WI = winter-spring/cool-season ephemerals; NS = non-seasonal ephemerals; AP = facultative annuals or perennials; PR = perennials.

Species	Region			Growth Form				
				Ephemerals			Facultative annuals or perennials	Perennials
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter	Non-seasonal		
FAGACEAE								
†*Quercus turbinella*	OP							PR
FOUQUIERIACEAE								
†*Fouquieria splendens*	OP	CP	TA					PR
GENTIANACEAE								
Eustoma exaltatum	OP							PR
Zeltnera arizonica	OP					NS		
GERANIACEAE								
**Erodium cicutarium*	OP	CP	TA		WI			
†*Erodium texanum*	OP	CP	TA		WI			
Geranium caroliniianum	OP				WI			
GROSSULARIACEAE								
Ribes quercetorum	OP							PR
KOEBERLINIACEAE								
†*Koeberlinia spinosa*	OP	CP	TA					PR
KRAMERIACEAE								
Krameria bicolor	OP	CP	TA					PR
†*Krameria erecta*	OP	CP	TA					PR
LAMIACEAE								
Agastache wrightii	OP							PR
†*Condea albida*	OP	CP	TA					PR
†*Hedeoma nana*	OP	CP						PR
†*Monardella arizonica*	OP		†TA					PR
Salvia columbariae	OP	CP			WI			
††*Salvia mohavensis*	OP		TA					PR
†*Salvia pinguifolia*	OP							PR
***Salvia reflexa*	OP				WI			
Salvia vaseyi		CP						PR
Scutellaria mexicana	OP	CP	TA					PR
Tetraclea coulteri	OP	CP						PR
Teucrium cubense	OP	CP				NS		

Teucrium glandulosum	OP	CP	TA					PR
LINACEAE								
**Linum bienne*	OP				WI			
LOASACEAE								
Eucnide rupestris	OP	CP				NS		
Mentzelia affinis	OP	CP			WI			
Mentzelia desertorum		CP	TA		WI			
Mentzelia involucrata	OP	CP			WI			
Mentzelia isolata	OP			SU				
Mentzelia longiloba	OP	CP	TA		WI			
Mentzelia puberula		CP	TA				AP	
Petalonyx linearis	OP		TA					PR
Petalonyx thurberi	OP	CP						PR
LYTHRACEAE								
***Punica granatum*	OP							PR

FAGACEAE – Beech Family

Nearly worldwide; 7 genera, 670 species.

Quercus – Oaks

Trees and shrubs. Mostly northern hemisphere, not in deserts except sometimes at desert edges; 400 species.

Quercus turbinella Greene

[*Q. ajoensis* C.H. Muller. *Q. turbinella* subsp. *ajoensis* (C.H. Muller) Felger & C.H. Lowe]

Scrub oak; *encinillo*. Figure 2.

Shrubs or trees to 8 m tall. Bark gray, rough and fissured on trunk and larger limbs. Leaves evergreen or ultimately deciduous in late spring–early summer during extreme drought. Leaves alternate, often 1–3.5 (5) cm long, broadly oblong to ovate or rounded, tough, often glaucous bluish-green, mostly glabrous above and glabrate below; margins with spine-tipped teeth or leaves sometimes entire, especially in shade. Flowers unisexual, wind pollinated, small and inconspicuous, without petals; male flowers many in pendulous catkins; female flowers solitary or in small clusters. Flowering in April, the small acorns ripening in summer. Acorns partially surrounded by a cup, annual, and on stalks (peduncles) often to 1.5+ cm long.

Ajo Mountains in Alamo and Arch canyons, Bull Pasture, and widespread at higher elevations. In Alamo Canyon and along the Bull Pasture Trail there are small groves of trees with well-formed, often single trunks. One tree in Alamo Canyon had a trunk nearly 1 m in diameter, and in such places there is extensive oak-leaf litter. Some of these trees died as a result of the extended drought of 2001–2002. At higher elevations on the mountain these oaks are shrubs, often growing among rocks. The nearest known population is to the north in the Sand Tank Mountains.

This oak has been in the Ajo Mountains for at least 32,000 years. There are numerous late Wisconsin and early Holocene records for *Quercus turbinella* throughout sub-Mogollon Arizona mountains (Betancourt et al. 1990). This oak ranges from California to Utah, Texas, and northern Mexico including Baja California and northernmost Sonora. As the common name "scrub oak" indicates, it is generally a shrub. The tree-sized stature of *Q. turbinella* in Alamo Canyon is notable. Elsewhere tree-sized individuals of *Q. turbinella* are usually rare, e.g., near the San Pedro River near

Winkelman in Pinal County (Phil Jenkins, pers. comm. to Felger, 2005). There are only a few places, such as the Ajo Mountains, and in the Lower Gila Box along the Gila River in southwestern New Mexico, where more than an occasional individual reaches tree size (more than 5 m tall with a well-formed trunk). Like so many oaks, these giants likely share genes with other, related white oaks (sect. *Quercus* = *Leucobalanus*).

Figure 2. *Quercus turbinella*. (A) By Lucretia Breazeale Hamilton. Alamo Canyon above Alamo Well: (B) New shoots and flowers, 12 Mar 2005; (C) Galls, 12 Mar 2005; (D) 28 Feb 2009; (E) 7 Feb 2013.

Quercus turbinella in the Ajo Mountains was a potential source of edible acorns, which probably were ground into meal and consumed as cakes or gruel.

The scrub oak in the Ajo Mountains and nearby southern Arizona mountains was named as a distinct species, *Quercus ajoensis*, and also as a subspecies of *Q. turbinella*. Nixon (1997) in the Flora of North America recognized *Q. ajoensis* as a distinct species, as did Spellenberg (2001) for the oaks of the U.S.–Mexico border region. For the oaks of Arizona, Landrum (1993) treated *Q. ajoensis* as a synonym of *Q. turbinella*. The distinctions are technical, involving pubescence, and are not easy to decipher. Treating *Q. ajoensis* as a subspecies of *Q. turbinella*, as Felger and Lowe (1970) did, may make sense biologically but is not practical. Among the 400 species of oaks around the world, too often one finds continuous, indistinct boundaries between the species. Distinguishing subspecies or varieties among oaks can be a futile exercise, like constructing a taxonomic house of cards and inviting dissension among botanists. Botanical taxonomy can be contentious and political (see *Acacia*, Fabaceae, in the present flora series), but it is the essential poetry of the diversity of life.

OP: Alamo Canyon, 19 Mar 1933, *Shreve 6200*. Along wash in main fork of Alamo Canyon, tree with scaly thin gray bark and sprawling branches, 2675 ft, 15 Aug 1952, *Muller 9519 & Tucker* (isotypes of *Q. ajoensis*, ARIZ, NMC, NY, ORPI). Bull Pasture Trail, 3000 ft, *Bezy 25 Oct 1964*. Arch Canyon, canyon bottom, 3 May 1978, *Bowers 1303*. Upper reaches of Alamo Canyon, bottom of ravine, 30 Mar 1989, *Baker 7601* (ASU). †Alamo Canyon, twigs, leaves, acorns, 8130 to 32,000 ybp (6 samples). †Montezuma's Head, twigs, leaves, acorns, 13,500 to 21,840 ybp (4 samples).

FOUQUIERIACEAE – Ocotillo Family

A family of one genus.

Fouquieria – Ocotillo

Spiny shrubs or trees. Dry regions of Mexico, 11 species, with 1 extending into the USA. Includes the boojum tree or *cirio*, *Fouquieria columnaris*. The system of branching and spine formation in *Fouquieria* is unusual but not entirely unique. For example, convergence occurs among *Sesamothammus* in the Pedaliaceae, native to eastern and southern Africa, and *Fouquieria*. Some *Sesamothammus* and *Fouquieria* have similar leaf-spine formation, and some of the species of *Sesamothammus* approach some Mexican *Fouquieria* species in gross morphology including growth form.

Fouquieria splendens Engelmann subsp. **splendens**
Ocotillo; *ocotillo*; melhog. Figure 3.

Unique long-lived desert "shrubs" often 2–3+ m tall, with slender, few-branched, wand-like spiny branches arising from a very reduced trunk or more often trunkless. Long shoots produced during warmer weather and high soil moisture, such as during summer rains and especially in the wake of a fall hurricane-fringe storm, or occasionally in spring. Long shoots with alternate, widely spaced nodes, these leaves with well-developed petioles, which form a rigid spine from the petiole and leaf-blade midrib (Figure 3C). Short shoots in axils of the spines, their internodes extremely reduced and not apparent, with leaves clustered and sessile, appearing at almost any time of year following a ground-soaking rain except during freezing weather, quickly becoming yellow and shedding as the soil dries or with freezing weather (Figure 3A and F). Inflorescences of densely flowered panicles at branch tips, often (6) 19–24 cm long, with conspicuous leafy bracts falling at anthesis. Flowers bright red-orange, the corolla fused below into a tube, with 5 reflexed lobes. Flowering mostly late February–March, attracting hummingbirds; fruits ripening in late spring. Fruit a capsule, with 6–15 flat, papery-winged seeds.

Ubiquitous across the region on desert flats and rocky slopes to the summits of most of the desert peaks, including the crestline of the Ajo Mountains, and also on the Pinta Sands and locally on sand flats.

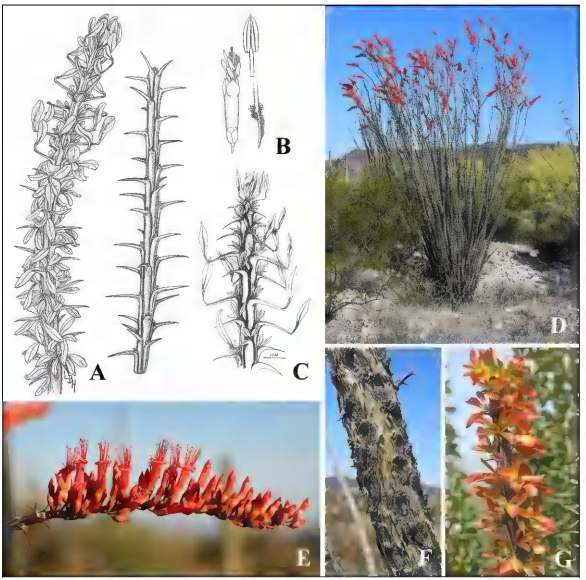

Figure 3. *Fouquieria splendens* subsp. *splendens*. (A) By Lucretia Breazeale Hamilton. (B) By Frances E. Runyan. (C) By Nancy Evans. (D) Little Ajo Mountains, 6 Apr 2015. (E) Alamo Canyon, 7 Apr 2005. (F) Old stem, southern Ajo Mountain Drive, 17 May 2015. (G) Drought-stressed leaves prior to shedding, near Victoria Mine, 1 Apr 2010.

Widespread across the Sonoran, Mojave, and Chihuahuan deserts to elevations well above the deserts; two other subspecies occur in the Chihuahuan Desert in Mexico (Henrickson 1972).

The oldest Sonoran Desert records for ocotillo are from the late Holocene. Considering the ecological amplitude (range of habitats) and wide geographic range of this species, its apparent late arrival and rarity in packrat midden assemblages are somewhat surprising.

Nectar can be sucked from the flower base for a trailside snack (Barrows 1900; Felger et al. 1992). The flowers were steeped in water for a beverage (Bean & Saubel 1972). Nectar pressed from the flowers hardens when dry and was chewed as a delicacy (Castetter & Bell 1942). The Cahuillas parched and ground the seeds to make a gruel or cakes (Bean & Saubel 1972). Ocotillo was used as a framework for traditional Hia-Ced brush houses (Betty Melvin in Zepeda 1985: 34). Living fences

made from the stems (Bean & Saubel 1972; Castetter & Bell 1942) continue to be popular in the region.

OP: Growler Well, *Nichol 27 Apr 1939* (ORPI). Growler Mts, foothills, 16 Apr 1952, *Parker 7986.* Quitobaquito, 29 Mar 1988, *Felger 88-132.* Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation). †Puerto Blanco Mts, on ridge, spines, 130 & 3440 ybp.

CP: Observations: Agua Dulce Mts, Cabeza Prieta Tanks, Charlie Bell Pass, Granite Pass Tank, Halfway Tank, NE of Tule Well, 12–15 Jun 1992, *Felger.* 100 m N of Camino del Diablo 5.5 mi ENE of Papago Well, 300 m, granitic hill with crude rock-walled circle at summit used by smugglers as a lookout, many stems with leafy, young long-shoots, flowers bright red-orange, common and widespread, 26 Mar 2010, *Felger 10-119.*

TA: Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-15.* Tinajas Altas Mts, near the summit, 26 Oct 2004, *Felger* (observation). †Butler Mts, stem fragment with spines, 740 ybp.

GENTIANACEAE – Gentian Family

Annual to perennial herbs, mostly glabrous (those in the flora area). Leaves mostly opposite, simple, usually entire, often clasping the stem; stipules none. Flowers usually bisexual and radial, often showy, 5-merous (those in the flora area), the calyx persistent, the calyx and corolla each united below. Fruit a capsule; seeds minute, and numerous.

Worldwide; 88 genera, 1675 species. Mostly in moist, cool, often montane, arctic or alpine habitats; few in deserts and hot climates. Apart from two other *Zeltnera* species at the desert edge, ours are the only gentians in the Sonoran Desert.

1. Leaves glaucous blue-green; corollas white, the tube 2–3 cm long, anthers not twisting ..... **Eustoma**
1. Leaves green, not glaucous; corollas bright pink, the tube 1–2 cm long, the anthers twisting after the flowers open..... **Zeltnera**

Eustoma – Prairie Gentian, Catchfly Gentian

This genus has a single species.

Eustoma exaltatum (Linnaeus) Salisbury ex G. Don subsp. **exaltatum**
Catchfly prairie gentian; *hawañ ta:tad.* Figure 4.

Annuals or short-lived perennials. Stems erect and leafy, 30–75 cm tall; herbage glaucous blue-green, winter deciduous. Leaves opposite, 2–6 cm long, the lowest leaves short petioled, the stem leaves sessile, clasping, and often fused basally, obovate to broadly elliptic or oblong, relatively thick and firm, the margins entire. Inflorescences of panicles. Flowers showy, 2.5–4 cm long, with mostly long pedicels. Calyx deeply cleft, the lobes slender and keeled. Corollas shiny cream-white or very pale blue, with 5 large, erect to partially spreading lobes. Anthers yellow. Capsules 1–1.5 cm long, oblong, thickened and tough, rough-surfaced, and many-seeded. Seeds 0.5 mm wide, rounded, deeply pitted, gray, and iridescent. Flowering during the warmer months.

Locally common in alkaline and saline wet soil at Burro, Quitobaquito, and Williams springs. Not known elsewhere in the flora area.

Three subspecies, southern USA to northern South America, and the West Indies. Across much of its range the corollas of *Eutoma exaltatum* are variously blue to purple. Subspecies *exaltatum* with white petals is known as forma *albiflorum* Benke. Selections of subsp. *exaltatum* and *E. exaltatum* subsp. *russelliamum* are grown as garden plants and there are a number of horticultural selections.

OP: Quitobaquito: *Mearns 7 Feb 1894* (US); *Harbison 27 Nov 1939* (SD); 17 Mar 1945, *Darrow 2401*; Wet slopes near springs, flowers whitish or very pale blue, 25 Nov 1972, *Pinkava 9995* (ASU). Williams Spring, locally common at springs seeping from edge of low hills, 13 Sep 1986, *Felger 86-268*.

Figure 4. *Eustoma exaltatum*. Quitobaquito: (A) 11 Sep 2008; (B) 10 Sep 2007; (C & D) 13 Sep 2006.

Zeltnera – Centaury

Annuals. North and South America; 25 species. A genus segregated from *Centaurium*.

Zeltnera arizonica (A. Gray) G. Mansion

[*Centaurium arizonicum* (A. Gray) A. Heller. *C. calycosum* (Buckley) Fernald var. *arizonicum* (A. Gray) Tidestrom]

Arizona centaury. Figure 5.

Ephemerals, 12–80 cm tall, the stems erect, single to much-branched; herbage green. Leaves sessile, 1–4 cm long, lanceolate or oblanceolate to ovate or obovate, with entire margins. Inflorescences of terminal cymes. Flowers showy; pedicels often about as long as the calyx tube. Calyx lobes linear, separate nearly to the base. Corollas bright pink, 5-lobed, the lobes 7–12 mm long and spreading, the throat yellow-green (elsewhere in southern Arizona the corollas are sometimes white). Filaments and style white, the anthers and stigma yellow; anthers twisting spirally after dehiscence. Capsules 1 cm long, oblong, the walls thin and smooth. Seeds 0.35–0.45 mm long, ovoid, minutely reticulate and pitted, gray, and iridescent. Flowering March–November.

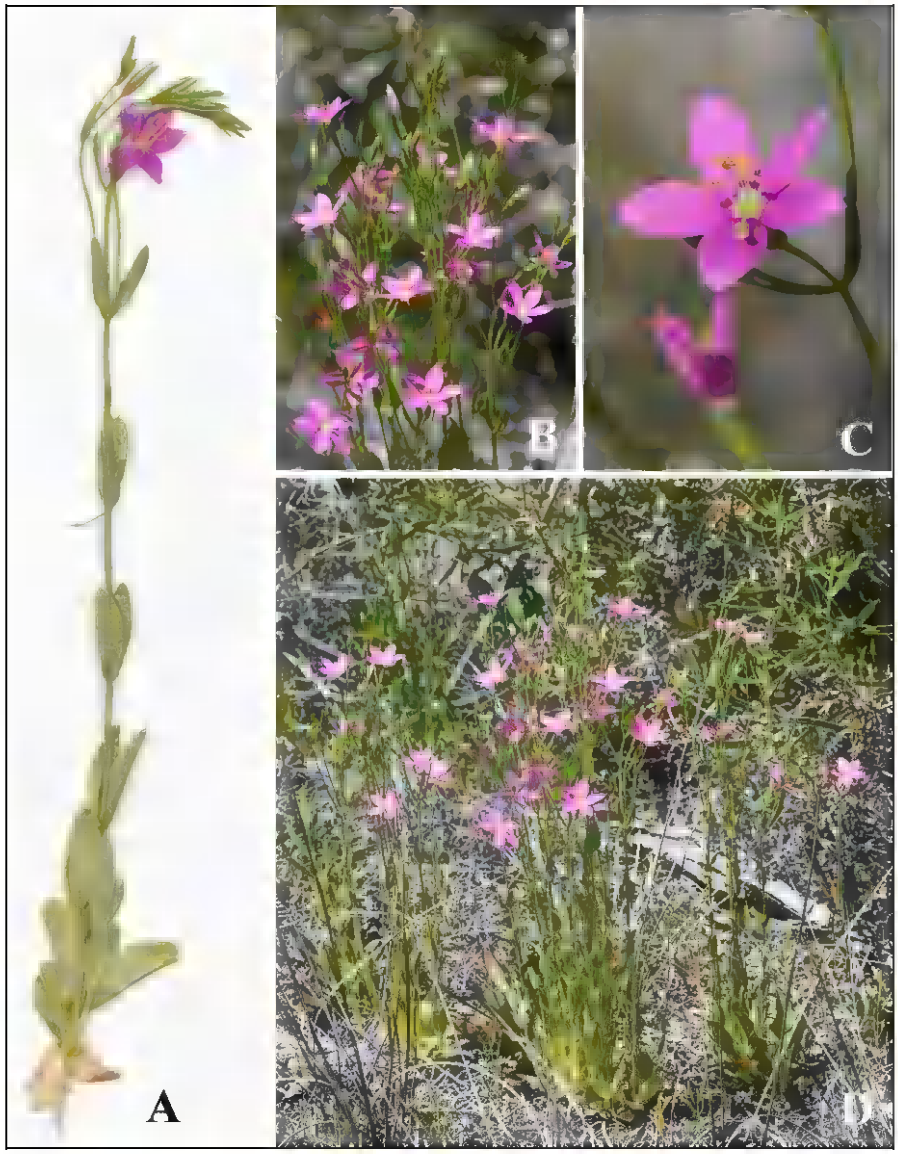

Figure 5. *Zeltnera arizonica*. Quitobaquito: (A) 3 May 2008; (B–D) 5 Mar 2005.

Locally abundant in alkaline and saline wet soil at seeps and springs from Quitobaquito to Williams Spring. Not known elsewhere in the region.

Alkaline wetlands in southwestern USA and northern Mexico.

OP: Quitobaquito: *Fouts 15 Jun 1949* (ORPI); 4 May 1978, *Bowers 1308*; 3 Sep 1980, *Nabhan 146*; 23 Jul 1986, *Felger_86-212*; 23 May 1991, *Baker 8357* (ARIZ, ASU). Williams Spring, 13 Sep 1986, *Felger 86-272*.

GERANIACEAE – Geranium Family

Ephemerals (those in the flora area; perennials and shrubs elsewhere). Leaves opposite, with stipules. Inflorescences umbellate or cymose. Flowers radial, the sepals and petals 5 and separate.

Fruit a capsule, beaked and distinctive by its elastic dehiscence and separation of the segments (mericarps).

Both hemispheres, largely tropical and temperate, especially Africa; 14 genera, 730 species. The garden and greenhouse geraniums belong to the genus *Pelargonium*. Ornamental geraniums are sometimes cultivated in Sonoran Desert gardens but they suffer from the extreme heat of summer and are frost sensitive.

1. Flowers with 5 functional stamens (with anthers); fruits including the beak (2.6) 3–5 cm long; widespread..... **Erodium**
1. Flowers with 10 functional stamens; fruits including the persistent style column to 2.5 cm long; Ajo Mountains..... **Geranium**

Erodium – Stork's bill

Winter-spring ephemerals. First leaves in a basal rosette. Flowers lavender-pink. The long, corkscrew-like beak on each fruit segment uncoils when moistened and screws the sharp-pointed and heavier seed-bearing end into the ground.

Mostly Old World; 75 species. Several are important forage plants and some Old World perennials are cultivated as ornamentals in temperate regions, especially in rock gardens. Young plants of the two Sonoran Desert species were eaten as greens, fresh or cooked, by the Cahuillas and others (Bean & Saubel 1972; Hodgson 2001).

1. Leaf blades pinnately dissected, much more than twice as long as wide, the petiole shorter than the blade..... **Erodium cicutarium**
1. Leaf blades ovate to 3–lobed or 3–parted, less than twice as long as wide, the petiole longer than the blade..... **Erodium texanum**

***Erodium cicutarium** (Linnaeus) L'Héritier ex Aiton
Filaree, heron's bill, stork's bill; *alfilerillo*; hoho'ibad. Figure 6.

Stems sometimes to 30+ cm, usually much shorter or essentially stemless (dwarfed rosette plants). Herbage with glandular and non-glandular white hairs, the glands minute. Leaves pinnatifid, mostly twice divided, much longer than wide, the blades 2–15+ × 0.8–4 cm, the petioles 1.8–7.5 cm long. Umbels (1) 3–7-flowered. Flowers 11–14 mm wide, the petals lavender-pink, readily falling, slightly longer than the sepals. Fruiting sepals 5–6.5 mm long. Beak of fruits 2.7–3.8 cm long. During highly favorable conditions the plants occasionally reach 2 m across with lower leaves to 27 cm long, peduncles 8–14 cm long, and fruit beaks 3.5–4.5 cm long.

Widely scattered and thoroughly established across the flora area; washes, gravelly flats, bajadas, rocky slopes to higher elevations, and especially disturbed habitats such as roadsides.

Widespread in the Sonoran Desert. Native to the Mediterranean region, widely naturalized and weedy in non-tropical regions worldwide.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Growler Canyon (E of Bates Well), 19 Mar 1975, *Lehto L18312* (ASU). Aguajita Wash, 3 Mar 1992, *Felger 92-121* (ARIZ, DES). Quitobaquito, 6 Apr 1988, *Felger 88-279*. Trail above Bull Pasture, 15 m below crestline, 4090 ft, 10 Apr 2005, *Felger 05-296*.

CP: San Cristobal Wash, 20 Mar 1992, *Harlan 19*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3917*. Redtail Tank, *Griffin 24 Feb 1995* (CAB).

TA: Coyote Water, 21 Feb 2005, *Felger 05-143*. Tinajas Altas Mts, above the tinajas, 19 Mar 1998, *Felger* (observation).

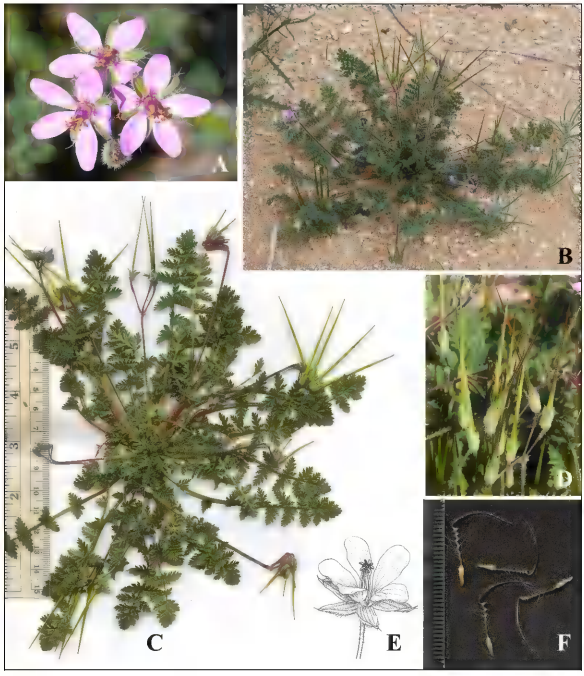

Figure 6. *Erodium cicutarium.* (A) Estes Canyon, 2 Mar 2008. (B) Ajo, 29 Dec 2014. (C) Dunes 37 km SW of Sonoyta on Mex Hwy 8, Sonora, 6 Feb 2014. (D) Near Mex Hwy 8, Sierra Los Tanques, Sonora, 27 Mar 2010. (E) By Lucretia Breazeale Hamilton. (F) N-facing slope of North Puerto Blanco Mts, W of Dripping Springs, 15 Mar 2015.

Erodium texanum A. Gray
Texas filaree, desert stork's bill. Figure 7.

Stems sometimes reaching 25+ cm long, but usually much shorter or essentially stemless. Herbage with small, coarse white hairs, not glandular. Petioles 10–42 mm long, leaf blades 9–21 mm long, ovate to heart-shaped or rounded in outline, usually 3-lobed or parted, the margins toothed; opposite leaves in a pair tend to be unequal in size. Umbels 2–3-flowered. Petals pink-purple,

readily falling, longer than the sepals. Fruiting sepals 5.5–9 mm long. Beak of fruit (2.6) 3.2–5 cm long.

Figure 7. *Erodium texanum*. (A) Valley of the Ajo, W of mile 60, Hwy 85, 16 Mar 2008. (B) Coffeepot Mountain, Sikort Chuapo Mountains, Maricopa Co., 26 Feb 2005. (C) N-facing slope of North Puerto Blanco Mts, W of Dripping Springs, 15 Mar 2015. (D) Kuakatch Wash near Hwy 85, 5 Feb 2005. (E) Slovan Well, Crater Range, Maricopa Co., 22 Jan 2014.

Widespread; washes, bajadas, plains, sandy flats, and sometimes on dunes. Its history in the Tinajas Altas Region extends to 10,400 years.

Southeastern California to southwestern Utah and Texas to northern Mexico including Baja California, northern Sonora, and northern Chihuahua.

OP: Grass Canyon, *Jackson 3 Mar 1965* (ORPI). Pozo Nuevo, 30 Mar 1978, *Bowers 1102* (ORPI). Dripping Springs, 30 Jan 1986, *Phillips_86-8* (ORPI). W side of Sierra Santa Rosa, 12 Mar 2003, *Felger 03-335*.

CP: Near Tule Well, 19 Mar 1992, *Yeatts 3229* (CAB, DBG:KHD). 0.2 mi W. of San Cristobal Wash, 11 Apr 1992, *Harlan 151*. 2 mi W of ORPI boundary on road from Bates Well to Papago Well, 31 Jan 1992, *Felger* (observation). Pinta Sands, 11 Apr 1993, *Felger 93-398*.

TA: Camino del Diablo, SSE of Raven Butte, 20 Feb 2005, *Felger* (observation). †Butler Mts, fruit, 10,360 ybp. †Tinajas Altas, fruit, 8970 ybp.

Geranium – Cranesbill

Annual and biennial herbs. Worldwide; 400 species.

Geranium carolinianum Linnaeus

Carolina crane's bill, Carolina geranium. Figure 8.

Spring ephemerals. Plants cespitose or with stems to about 50 cm long, densely pubescent with short, downward pointing hairs. Lower (larger) leaves 10–15 cm long, the blades 2–6 cm wide, palmately lobed with 5 oblong to wedge-shaped deeply cleft segments. Flowers 1–several in clusters. Pedicels 2–7 mm long; sepals 4–7 mm long and short-awned; petals probably white to pale lavender, about as long as the sepals, the tip notched. Fruit body 2–3 mm long. Seed faintly pitted.

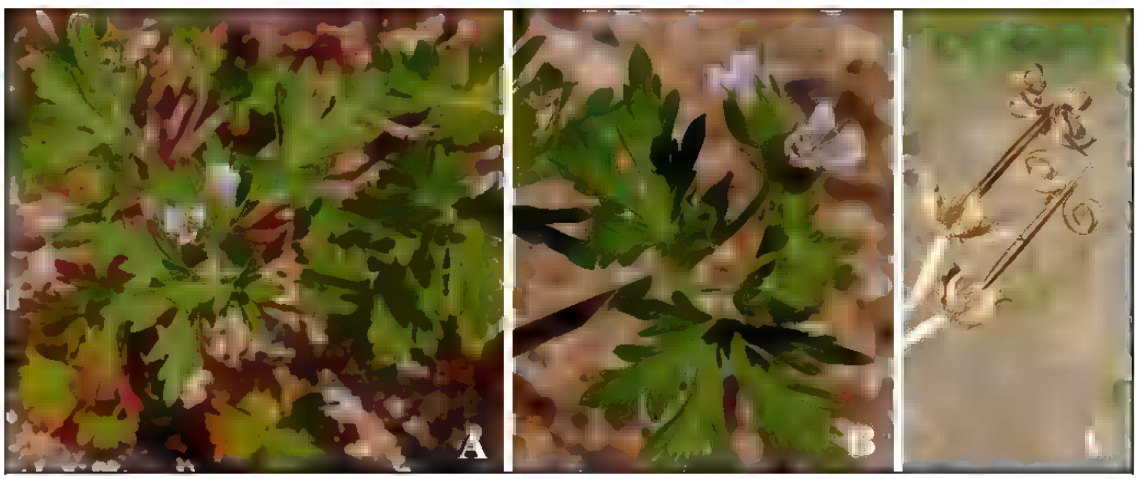

Figure 8. *Geranium carolinianum*. (A & B) Sycamore Creek, State Route 87 at Mt Ord turnoff, Gila Co., 6 Apr 2011, photo by Eugene Sturla (SEINet). (C) El Cerrito, near intersection of Potrero Avenue and BART, Contra Costa Co., CA, 30 Sep 2009, photo by Zoya Akulova (CalPhotos).

Ajo Mountains in canyon bottoms at elevations above about 3200 feet.

Eastward in southern and central Arizona at elevations above the desert. Canada to northern Mexico. Widely naturalized in South America and Eurasia.

OP: Head of Estes Canyon, among rocks in streambed, 3200 ft, 9 May 1979, *Bowers 1711*. Bull Pasture, canyon on N side, along canyon floor, 27 Mar 1985, *Phillips & Phillips 85-9* (MNA).

GROSSULARIACEAE – Gooseberry Family

A family of one genus with 150 species. Shrubs in temperate northern hemisphere and the Andes.

Ribes quercetorum Greene
[*Grossularia quercetorum* (Greene) Coville & Britton]
Oak gooseberry. Figure 9.

Shrubs to 1.5 m tall. Leaf nodes usually with a sharp, slender spine. Leaves alternate, simple, petioled, the blades glandular hairy (stipitate glandular), 1–2 cm wide and about as long, cleft into 3 or 5 segments, the margins toothed. Inflorescences of axillary racemes with 2 or 3 flowers. Flowers 5-merous; tubular, with a yellow hypanthium 2–3 mm long; petals cream-white, with lobes 1 mm long; February. Fruits of fleshy, edible berries 6–9 mm in diameter, shiny and blackish when ripe in late spring.

Figure 9. *Ribes quercetorum*. (A) Above The Cones, Ajo Mts, 22 Oct 2006. (B) Pinnacles National Monument, San Benito Co., CA, 24 Feb 2004, photo © by Keir Morse (CalPhotos).

Ajo Mountains, higher elevations, in canyon bottoms and rocky, often north-facing slopes. This is the closest encounter with the desert for this genus.

Mountains in south-central Arizona, California, and Baja California; it is a species of chaparral and oak woodland.

The fruits are edible, fresh, dried, or cooked and made into jelly (Moerman 1998).

OP: Ajo Mts, deep shaded canyon S of arch, wide crack in N-facing cliff, 18 Feb 1978, *Fay 739*. Trail from Bull Pasture to Mount Ajo, very steep, N-facing slope near crestline of Ajo Mts, 22 Oct 2006, *Rutman 20061022-5*.

HYDROPHYLLACEAE, see **BORAGINACEAE** (Felger et al. 2015).

KOEBERLINIACEAE – Allthorn Family

This family of a single genus includes two species: *Koeberlinia spinosa* in North America and the similar looking *K. holacantha* in the Chaco of Argentina, Bolivia, and Paraguay (Holmes et al. 2008). Koeberliniaceae is a member of the Brassicales, which includes the mustards (Brassicaceae), and is allied with Bataceae and Salvadoraceae, two families of very different appearing plants (Rodman et al. 1993; Stevens 2012; Tucker 2010).

Koeberlinia spinosa Zuccarini var. **tenuispina** Kearney & Peebles
Crucifixion thorn, allthorn; *corona de cristo*. Figure 10.

Spinescent, hardwood shrubs; minutely pubescent. Branches and twigs rigid, the twigs yellowish green, slender, and thorn-tipped. Leaves alternate, scale-like, very quickly deciduous, the plants essentially leafless. Inflorescences of small semi-persistent racemes. Flowers on slender

pedicels, whitish to sometimes pale yellow; sepals 4; petals 4, 4.5 mm long; stamens 8; flowers moderately stinky with a sweet, musty fragrance. Fruits of globose berries with a short stipe, drying capsule-like, 3–3.5 mm diameter, 2–4-seeded. Flowering at least April and June; fruits at least in May.

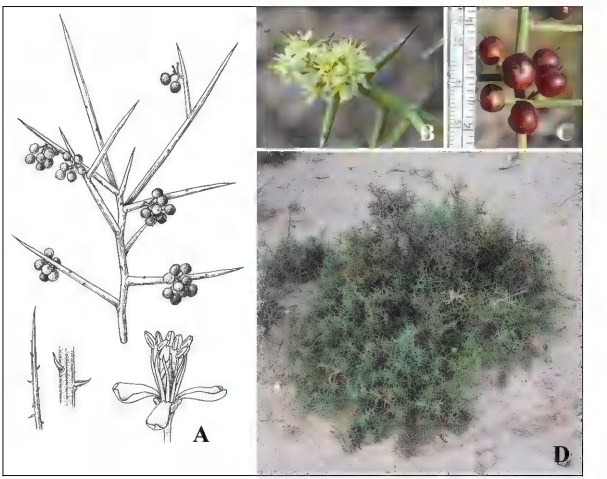

Figure 10. *Koeberlinia spinosa* var. *tenuispina*. (A) By Lucretia Breazeale Hamilton. (B) Eastern foothills of Tucson Mountains, near Grant Road, Pima Co., 24 Jul 2013. (C) Castle Dome Mts, 6 Apr 2014. (D) Gu Vo Road, E of Organ Pipe, Tohono O'odham Reservation, 10 Sep 2013.

Sprawling shrubs often 0.4–1 m tall and more than 1 m across, with thick, radiating lateral roots. Herbage densely pubescent with short, gray hairs, the stems glabrate with age. Stems intricately branched mostly at right angles, straight, slender, and sparsely leaved, the tips often somewhat spinescent. Leaves 5–10 (14) × 1.1–2.4 mm, soon drought deciduous, sessile, linear to oblong, often grayish. Flowers showy, with a strong, sweet fragrance, 1.5 cm wide, solitary or in short racemes with leafy bracts. Sepals bright magenta-purple inside, white hairy outside. Upper petals spear-shaped (narrowly spatulate), separate, bright chartreuse with purplish tips; oil-gland (lower) petals extremely thick, fleshy, slab-like, and dark purple (other colors reported for specimens from elsewhere; Simpson 1989). Fruits more or less globose, 1 cm wide, the spines with a terminal cluster of small barbs. Flowering various seasons.

Occasional plants on a sandy loam flat within 1 km of the northeastern corner of Organ Pipe and in the southeastern part of the Monument near the Mexican border. Common in areas north and east of the Monument, such as the Sand Tank Mountains in the Goldwater Range and Vekol Valley in

the Sonoran Desert National Monument. A single large shrub is known from the Pinacate Region in northwestern Sonora (Felger 2000). It was in the Tinajas Altas Region more than 10,000 years ago.

Holmes et al. (2008) recognized three varieties of *Koeberlinia spinosa*. Var. *tenuispina* is essentially a Sonoran Desert endemic in southwestern Arizona, southeastern California, Baja California, Baja California Sur, and western Sonora nearly to the Sinaloa border. It sometimes becomes a small tree 3–4 m tall on Isla Tiburón and in a few mainland Sonora locations. The hard wood does not float in water and when burned produces copious oily black smoke, which the Seris used in the 19th century to disinfect their houses during epidemics (probably measles) and to prevent diseases after visiting the town of Hermosillo (Felger & Moser 1985). Tea made from the flowers was taken as a remedy for dizziness and intestinal disorders, and tea made with the twigs mixed with *hierba del manso* (*Anemopsis californica*) was taken as a remedy for rheumatism (Felger & Moser 1985).

Var. *wivaggii* W.C. Holmes et al. is essentially a Chihuahuan Desert taxon occurring east of var. *tenuispina* and west of var. *spinosa* of Texas and northeastern Mexico. Var. *tenuispina* is distinguished from the other varieties by its sometimes arborescent habit, longer thorns, young thorns densely puberulent rather than glabrous or minutely puberulent, and slightly longer ovary/fruit stipes, styles, and petals. Although these distinctions may seem minor, they are geographically segregated.

OP: Sonoyta Valley, N of Dos Lomitas, 10 Jun 2011, *Sarah Howard*, photo (at least 2 plants, in flower). 6 mi E of Lukeville, close to international boundary, 135 m, *Conner 26 Mar 2013*.
TA: †Butler Mts, twig, 10,360 ybp.

KRAMERIACEAE – Ratany Family

This family has one genus. Krameriaceae and Zygophyllaceae are the only families in the order Zygophyllales.

Krameria – Ratany, rhatany

Small shrubs, taniferous (high tannin-like content). Hemiparasites; the roots contain red pigment. Leaves alternate, drought-deciduous and simple (those in the flora area); stipules none. Flowers bilateral, mostly purple and attractive; sepals 5 and showy, petal-like and much larger than the petals; petals 5, the 2 lower ones modified as elaiophores—thick, slab-like, fleshy, oil-secreting glandular structures. Stamens 4, the flowers buzz-pollinated with anthers opening by terminal pores. Fruits dry, indehiscent, 1-seeded, and bur-like with slender spines, resembling a miniature sea urchin.

Americas; 18 species (Simpson & Salywon 1999; Simpson et al. 1977, 1978, 2004).

"Probably all the species of the genus are hemiparasites, with the roots forming haustoria upon the roots of a variety of (mostly woody) hosts. The flowers of *Krameria* are nectarless and the rewards provided pollinators are fatty oils produced by the modified external surfaces of the lower two petals, the elaiophores. The pollination syndrome for the plants is an obligate mutualism with female digger bees of the genus *Centris* (Anthophoridae) which use the oils mixed with pollen for their larval food" (Simpson & Salywon 1999: 57; also see Cannon 1910, 1911 and Simpson et al. 1977, 1978). Seedlings lack root hairs and must attach to a root of a host within the first two months of life or perish (Cannon 1911). A similar pollination syndrome is seen with *Centris* bees and *Cottsia* (Malpighiaceae).

1. Branches mostly straight and without knotty spur-branches; spines of fruit with barbs in a terminal cluster; the 3 upper petals distinct (free), their blades near orbicular..... **Krameria bicolor**
1. Branches tough and knotty with many short spur-branches; spines of fruit with barbs along upper part of shaft; the 3 upper petals fused basally, their blades lanceolate..... **Krameria erecta**

Krameria bicolor S. Watson

[*Krameria bicolor* S. Watson (1886) has priority as the correct name for the species first named *K. canescens* A. Gray in 1852, but not *K. canescens* Willdenow ex Schultes 1827, and then renamed as *K. grayi* Rose & Painter (1906, based on the same type as *K. canescens* A. Gray); Simpson 2013.]

White ratany; *cósahui*; edho, he:d. Figure 11.

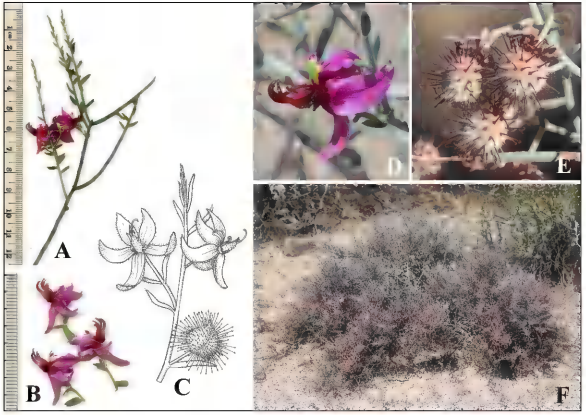

Figure 11. *Krameria bicolor*. (A & B) Dripping Springs, 12 Mar 2015. (C) By Lucretia Breazeale Hamilton. (D) Ajo, 4 Aug 2013. Trail to Victoria Mine: (E) 23 May 2006; (F) 23 Apr 2010.

Sprawling shrubs often 0.4–1 m tall and more than 1 m across, with thick, radiating lateral roots. Herbage densely pubescent with short, gray hairs, the stems glabrate with age. Stems intricately branched mostly at right angles, straight, slender, and sparsely leaved, the tips often somewhat spinescent. Leaves 5–10 (14) × 1.1–2.4 mm, soon drought deciduous, sessile, linear to oblong, often grayish. Flowers showy, with a strong, sweet fragrance, 1.5 cm wide, solitary or in short racemes with leafy bracts. Sepals bright magenta-purple inside, white hairy outside. Upper petals spear-shaped (narrowly spatulate), separate, bright chartreuse with purplish tips; oil-gland (lower) petals extremely thick, fleshy, slab-like, and dark purple (other colors reported for specimens from elsewhere; Simpson 1989). Fruits more or less globose, 1 cm wide, the spines with a terminal cluster of small barbs. Flowering various seasons.

Common and widespread through most of the lowlands of the region, especially in sandy to gravelly soils of washes, plains and bajadas, and sometimes on rocky slopes.

Southeastern California to western Texas and southwestern Utah, and northwestern and north-central Mexico.

The thick roots have had widespread use in the Sonoran Desert as a source of dyes and medicines (e.g., Castetter & Underhill 1935; Felger 2007; Felger & Moser 1985; Felger et al. 1992; Rea 1997). The roots were an important source of reddish-brown to pinkish dye, especially for basketry and fabrics; they were also prepared for cosmetics and as a tanning agent for deer hides. Hia-Ced O'odham women's buckskin dresses were sometimes "made red with a dye made from a small bush which the Mexicans call Cosawi" (Childs 1954: 36). Hia-Ced O'odham women "use edho (a red dry plant) . . . [to] paint their cheeks and lips. . . . Women who paint with these plants are women who dance" (Betty Melvin in Bell et al. 1980: 101). This plant has been used by the Gila River Pimas to treat diabetes and numerous other remedies, such as for diarrhea, upset stomach, stomach sores (ulcers), skin sores, kidney problems, sore throats or bad colds, arthritic pain, and tuberculosis and to facilitate healing, prevent infection, and purify the blood (Rea 1997).

Common and widespread through most of the lowlands of the region, especially in sandy to gravelly soils of washes, plains and bajadas, and sometimes on rocky slopes.

Southeastern California to western Texas and southwestern Utah, and northwestern and north-central Mexico.

OP: 8 mi S of Growler Well, *Nichol 17 Apr 1939*. Alamo Canyon (see Mulroy 1971). 2 mi S of Kuakatch Wash on power line road, 24 Jul 1978, *Bowers 1386*. Senita Basin, 6 Dec 1978, *Hodgson H201* (DES). Quitobaquito, 14 Sep 1988, *Felger 88-446*.

CP: Charlie Bell Well, *Johnson 26 Mar 1960*. Buck Mt Tank, *Duncan 28 Mar 1970* (CAB). Christmas Pass, 13 Apr 1992, *Harlan 271* (CAB). Observations: N side of Sheep Peak, 31 Jan 1992, *Felger*; Pinta Sands, 1 Feb 1992, *Felger*.

TA: Tinajas Altas, canyon below tanks and on rocky slopes, 19 Mar 1998, *Felger* (observation). Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-16*.

Krameria erecta Willdenow ex Schultes
[*K. parvifolia* Bentham]
Littleleaf or range ratany; *cósahui*. Figure 12.

Dwarf shrubs often 0.3–0.5 m tall, with many short, rigid branches, the branches appearing knotty due to many very short spur branches. Herbage densely pubescent and grayish with short whitish hairs. Leaves drought deciduous, 3–9 × 0.8–1.3 mm, sessile, and linear. Flowers showy, 1.5 cm wide, solitary or in short racemes with leafy bracts. Sepals bright magenta-purple inside, white hairy outside. Upper petals expanded above into lavender blades and narrowed below into thick, bright green claws, the claws united below; oil-gland (lower) petals thick and very dark purple. Fruits globose and moderately compressed, 6 mm wide, the spines 3.5 mm long with small barbs distributed along the upper part of the shaft. Flowering various seasons.

Often on rocky soils, also sandy-silty soils; hills and mountains—sometimes to the summits of the drier mountains, bajadas, and rocky-gravelly plains; widely scattered across the flora area. It was in the Tinajas Altas Region more than 8200 years ago.

Southeastern California to southwestern Utah and Texas, and northwestern and north-central Mexico.

OP: Growler Mts, *Crooks 31 Mar 1937*. Pozo Nuevo, 16 Apr 1965, *Bennett 8768* (ORPI). 2 mi W of Bates Well, 30 Mar 1978, *Bowers 1127* (ORPI). Alamo [Canyon] Campground, *Beale 15 Mar 1986* (ORPI). Quitobaquito, 14 Sep 1988, *Felger 88-468*.

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3938* (CAB). Pinacate Lava, 15 Sep 1992, *Felger 92-766*. 4.7 mi E of Tule Well, 11 Apr 1993, *Felger 93-439*. Sunday Pass, Sierra Pinta, *Cain 15 Nov 2003*.

TA: Butler Mts, 27 Mar 1983, *Van Devender* (observation). 0.3 mi SE of Tinajas Altas, 22 Nov 2008, *Felger 08-191*. †Butler Mts, leaves, fruits and spines from fruits, 740 & 8160 ybp.

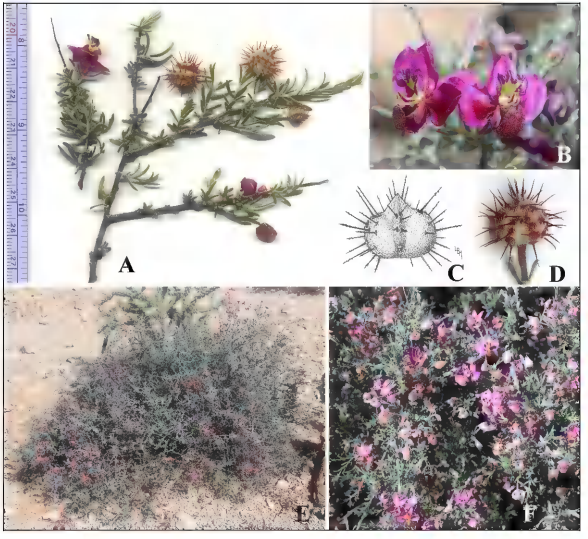

Figure 12. *Krameria erecta*. (A) Bajada E of Growler Mts, 13 Sep 2013. (B) Ajo, 31 Jul 2013. (C) By Lucretia Breazeale Hamilton. (D) Northern Bates Well Road, 4 Aug 2014. (E) On granite, Gunsight Hills, 10 Sep 2013. (F) Foothills E of Pinkley Peak, 8 Aug 2013.

LAMIACEAE (LABIATAE) – Mint Family

Ephemerals, perennial herbs, or shrubs; often aromatic. Stems square (4-angled) or sometimes rounded (terete) in cross section. Leaves opposite, sometimes whorled or in basal rosettes; stipules none. Sepals united into a tube, mostly 2-lipped with 5 lobes or teeth. Corollas bilateral, 5-lobed, mostly 2-lipped, the lower one usually larger. Stamens attached to the corolla tube, 4 and paired, or 2 and sometimes with an additional pair of staminodes. Style often cleft at tip into equal or unequal lobes, or one lobe vestigial. Fruits of 4 nutlets (1-seeded).

Worldwide; 236 genera, 7173 species.

1. Plants herbaceous or mostly so.

2. Spring ephemerals; larger leaves in a basal rosette and pinnatifid, the stem (cauline) leaves greatly reduced; stamens 2..... **Salvia** (in part, including **S. columbariae**)
2. Non-seasonal ephemerals or perennials; leaves not pinnatifid, the stem leaves well developed; stamens 4 (or 2 in **Hedeoma**)

3. Annuals (ephemerals), generally with a small root system; stems rather weak, soon spreading to decumbent..... **Teucrium cubense**
3. Obvious perennials with a well-developed root system; stems mostly firm and upright.

4. Plants glabrous or glabrate except youngest growth and flowers; leaves few-toothed and the larger ones lobed; corollas 18–26 mm long..... **Teucrium glandulosum**
4. Plants pubescent; leaf margins entire, serrated, or toothed; corollas 4–15 mm long.

5.Leaves sessile; corollas 10–15 mm long, white and spotted with violet..... **Monardella**
5. Leaves petioled; corollas 4–15 mm long, white, blue or lavender.

6. Plants stinky; corollas white and pinkish, 4–15 mm long…….. **Tetraclea**
6. Plants not stinky; corollas blue or lavender, mostly less than 10 mm long.

7. Leaves mostly 3–6+ cm long; flowers clustered (in verticils) on an interrupted spicate inflorescence; flowers to 10 mm long; stamens 4..... **Agastache**
7. Leaves mostly 1–1.5 cm long; flowers clustered in whorls among leaves in the upper stem nodes; flowers 6–7 mm long; stamens 2..... **Hedeoma**

1. Shrubs or subshrubs, at least the lower branches woody.

8. Plants densely pubescent with branched white hairs..... **Condea**
8. Plants appearing glabrous or with simple (unbranched) hairs.

9. Plants aromatic; leaves mostly more than 2 cm long, the margins minutely to coarsely toothed or scalloped; calyx toothed, not inflated like a bag; stamens 2 ..... **Salvia** (in part)
9. Plants not aromatic or not noticeably so; leaves mostly less than 2 cm long, the margins entire; calyx not toothed, the fruiting calyx inflated like a bag or balloon; stamens 4.
……..... **Scutellaria**

Agastache

Perennial herbs. North America and Asia; 22 species.

Agastache wrightii (Greenman) Wooton & Standley
Sonoran giant hyssop. Figure 13.

Herbaceous perennials to about 1 m tall, highly aromatic with abundant glands and short, white hairs. Stems leafy, the leaves mostly 3–6 cm long, prominently petioled; leaf blades lanceolate to ovate-dentate, the margins toothed, bicolored, green above, grayish below; first leaves in a basal rosette and larger than the stem leaves. Flowers clustered (in verticils) on an interrupted spicate inflorescence. Calyx persistent, 4–4.8 mm long, green with white teeth when fresh; corollas blue, extending 4–5 mm beyond the calyx. Stamens 4. Nutlets about 1 mm long.

Known in the flora area from a single locality in Alamo Canyon at 2400 feet, which is an unusually low elevation record for this species. One plant was found in 2013; by spring 2015 it had

perished although several young plants were seen near the mother plant. The nearest known populations are in the Coyote and Baboquivari mountains in Pima County.

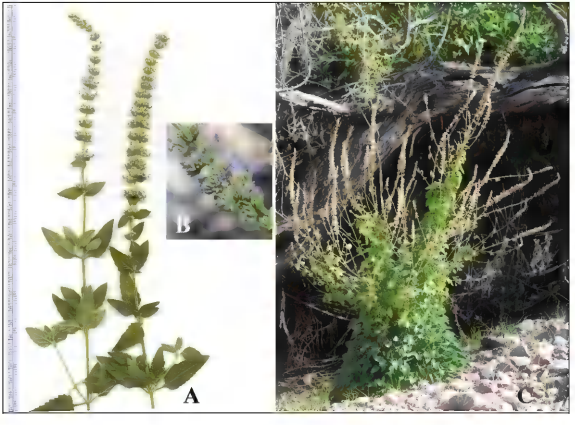

Figure 13. *Agastache wrightii*. Alamo Canyon: (A) 7 Sep 2013; (B) 9 Sep 2013; (C) 1 Feb 2014.

Sonoran giant hyssop is most often seen at 4000–6000 ft along streambeds in riparian oak woodland, where the plants often reach 75–150 cm tall. Flowering August and September. The fresh, aromatic herbage makes a fine tea.

Southern Arizona, southern New Mexico, western Chihuahua, and eastern Sonora.

OP: S fork of Alamo Canyon, 32.06539º, -112.71306º, 2400 ft, wash bed, single plant, about 1 meter tall, with *Prosopis velutina, Quercus turbinella, Lycium parishii, Ambrosia ambrosioides, Forestiera, Ambrosia cordifolia, Acaciella angustissima*, 7 Sep 2013, *Rutman 20130907-2* (det. Jim Verrier).

Condea

Trees and shrubs. North and South America; 26 species. A genus segregated from *Hyptis*.

Condea albida (Kunth) Harley & J.F.B. Pastore
[*Condea emoryi* (Torrey) Harley & J.F.B. Pastore. *Hyptis albida* Kunth. *H. emoryi* Torrey. *H. emoryi* var. *amplifolia* I.M. Johnston. *H. emoryi* var. *palmeri* (S. Watson) I.M. Johnston]
Desert lavender; *salvia*. Figure 14.

Shrubs 1–2.5 (3) m tall, with many straight, slender woody stems arising from the base. Branched white hairs generally form a dense vestiture on the leaves, twigs, pedicels, and calyces (especially the tube), and some on corollas and filaments, the foliage thus often whitish. Leaves

ovate, grayish or whitish to olive-green depending on moisture conditions, gradually and tardily drought deciduous; larger leaf blades mostly 1.5–3 cm long, the largest leaves on new primary-growth stems sometimes with blades to 5 cm and petioles to 3 cm. Leaf margins evenly crenulate to broadly toothed. The plants are frost sensitive and often show minor or occasionally severe freeze damage.

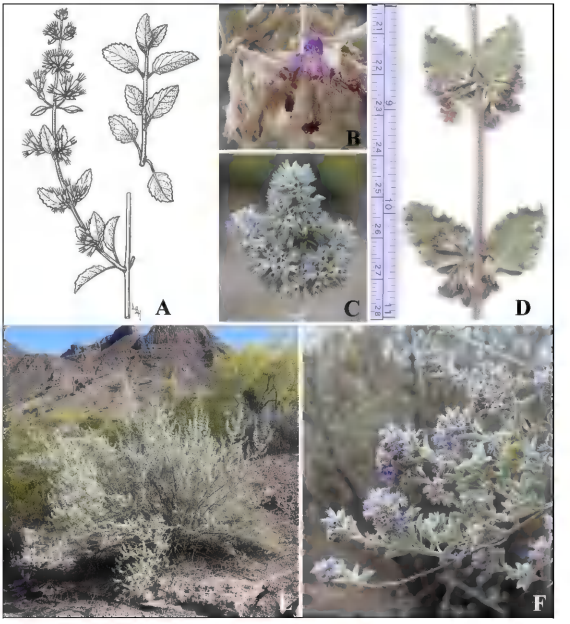

Figure 14. *Condea albida*. (A) By Lucretia Breazeale Hamilton. (B) Tinajas Altas, Yuma Co., 1 Mar 2014, photo by Sue Carnahan. (C) Growler Canyon, 20 Mar 2005. (D) Wash on N side of Little Ajo Mts, 2 Oct 2013. (E) N end of Growler Mts, 29 Mar 2014. (F) Wash on W base of Sierra Cubabi, Sonora, 6 Feb 2014.

Flowers highly fragrant, densely crowded in axillary and terminal clusters or racemes. Pedicels as long as to longer than the calyx. Calyx 4.6–6 mm long, 5 lobed, the lobes slender and purplish. Corollas longer than the calyx, bright lavender-blue and showy against the whitish foliage and calyces. Stamens 4 and fertile, the upper pair shorter. Flowering profusely much of the year except during freezing weather and extreme drought. Nutlets 1.5–2 mm long.

Widespread and common across most of the flora area, mostly in washes, canyons, and rocky slopes to the summits of the larger, drier mountains. It has been part of the regional flora for at least 8700 years.

Southwestern and central Arizona, southern Nevada, and southeastern California to Baja California Sur and northern Mexico to San Luis Potosí, Michoacán, and Guerrero.

We are treating *C. emoryi* (*Hyptis emoryi*) as a synonym of *C. albida* (also see Martin et al. 1998; Felger & Wilder 2012). The Sonoran Desert populations tend to be more densely white-pubescent than those of *C. albida* from non-desert regions farther south in Mexico, but the variation is continuous. The leaves of well-watered desert plants, especially following favorable, warm-season rains, can be much larger, greener (sparsely pubescent), and thinner than dry-season leaves and can resemble leaves of typical non-desert plants (see Smith & Noble 1977a, 1977b). Differences in pedicel length (reportedly longer in *C. emoryi*) and nutlets that are smooth (*C. albida* sensu stricto) vs. "minutely granular-roughened" (*C. emoryi*) are reported as key characters to distinguish them (e.g., Wiggins 1964: 1292–1293). Examination of dozens of specimens at ARIZ indicates that these features do not serve to separate the two taxa. Specimens from Arizona to Jalisco and San Luis Potosí show no discernable distinction in pedicel length and have smooth nutlets, without variation that serves to distinguish them (see Martin et al. 1998; Turner et al. 1995). Several varieties have been described, and across the large geographic range there is considerable variation in leaf shape that may have some taxonomic value.

Desert lavender was an important medicinal plant in the Sonoran Desert, used in combination with other medicinal plants or alone to treat asthma, colds, fever, tooth problems, and hemorrhaging (e.g., Bean & Saubel 1972; Felger & Moser 1985) and it was much appreciated for its fragrance (Felger & Moser 1985; Lumholtz 1912: 205). The Gila River Pimas smoked the leaves as tobacco (Rea 1997). The seeds have been reported as edible (e.g., Kirk 1970; Uphof 1968), but this is probably an error based on misinterpretation of Lumholtz's (1912: 204) use of "*Hyptis*" for *Salvia columbariae*.

OP: N of Dripping Springs, 9 Apr 1941, *McDougall 61*. N of Bates Well, *Tinkham 23 Apr 1942*. Senita Basin, *Warren 10 Apr 1975*. Pozo Nuevo, 11 Feb 1978, *Bowers 1051*. Quitobaquito hills, 24 Oct 1990, *Felger 90-483*. †Puerto Blanco Mts, on ridge, leaves, fruits, 130 to 7580 ybp (12 samples).

CP: Eagle Tank, 13 Jun 1992, *Felger 92-589* (CAB). Agua Dulce Tank, Cabeza Prieta Tanks, 15 Jun 1992, *Felger* (observation). 4.7 mi E of Tule Well, 11 Apr 1993, *Felger 93-440*. Sunday Pass, Sierra Pinta, *Cain 15 Nov 2003*.

TA: 1 mi N of Tinajas Altas, 17 Apr 1948, *Kurtz 1161*. †Butler Mts, twigs, leaves, fruits, 740 to 8570 ybp (3 samples). †Tinajas Altas, leaves, calyces, seeds, 1230 to 8700 ybp (6 samples).

Hedeoma

Annuals and herbaceous perennials. North and South America; 40 species.

Hedeoma nana (Torrey) Briquet subsp. **macrocalyx** W.S. Stewart
Dwarf false pennyroyal; *orégano*. Figure 15.

Perennial herbs 20–40 cm tall, the stems numerous and wiry; also flowering in the first season. Herbage highly aromatic. Leaves often 1–1.5 cm long, elliptic to ovate and acute, the lower surfaces usually purplish. Flowers small but showy, in short, clustered whorls at the upper stem nodes. Calyx unequally 5-toothed, conspicuously hairy, the calyx tube 3.5–4.5 mm long. Corollas 5–7+ mm long, bilabiate, lavender with darker spots and white ridges in the throat. Stamens 2. Flowering at least in spring.

Scattered localities in the larger mountains in Organ Pipe (Ajo, Diablo, Puerto Blanco mountains) and Childs Mountain in Cabeza Prieta; especially in rocky habitats, mostly along canyon bottoms and north-facing slopes and sometimes in large washes leading out of the Ajo Mountains. This or a similar pennyroyal grew in the Ajo Mountains 1200 to 13,500 years ago.

Subspecies *macrocalyx* in western, central, and southern Arizona and northern Sonora. Two other varieties, California, Nevada, and Utah to western Texas and northern Mexico to San Luis Potosí.

Figure 15. *Hedeoma nana*. Alamo Canyon: (A & C) 3 Sep 2014; (D) 17 Oct 2013. (B) Burro Creek, Yavapai Co., 29 Oct 2013, photo by Elizabeth Makings.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10852*. Alamo Canyon: 2500 ft, 11 Mar 1950, *Supernaugh 434*; 0.1 mi upstream from Alamo Well, *Wirt 27 Apr 2005*. Arch Canyon, 5 Apr 1978, *Bowers 1173*. Alamo Wash at Hwy 85, *Beale 28 Feb 1988* (ORPI). Large wash draining NE slopes of Pinkley Peak, 31 Oct 2003, *Rutman 2003-1031-17* (ORPI). Above Bull Pasture on trail to crestline, 3220 ft, 10 Apr 2005, *Felger 05-231*. †*H.* cf. *nana*: Alamo Canyon, fruits, 1150 & 9570 ybp. †Montezuma's Head, fruits, 13,500 ybp.

CP: Childs Mt, near summit in canyon bottom, mostly N and E sides of rocks, 5 Mar 1994, *Felger 94-11*. Growler Mts, vicinity of Growler Peak, just N of Charlie Bell Pass, 302721 E, 3587946 N, *Peter Holm 4 Apr 2014*.

Monardella

Annuals to shrubs. Western North America; 30 species.

Monardella arizonica Epling

Arizona monardella. Figure 16.

Herbaceous or sub-shrub perennials to 40 cm tall, aromatic, moderately to densely pubescent, and with rhizomes. Stems terete to 4-angled. Leaves mostly 0.5–2+ cm long, sessile, linear to elliptic or lanceolate, glandular punctate and with stalked glands. Flowers in head-like, stalked clusters subtended by green to purplish bracts to 1.5 cm long. Flowers sessile; corollas tubular, 1–1.5 cm long, white and spotted with violet, the upper lip 2-lobed, the lower lip 3-lobed. Stamens 4. Nutlets to 2 mm long. Flowering at least October and November.

Higher elevations in the Ajo Mountains; uncommon, growing from crevices in bedrock. It ranged across the flora area from at least 9000 to more than 37,000 years ago.

Western and southern Arizona, generally above the desert.

OP: Bench in Estes Canyon, *Henry 6 Nov 1977* (ORPI). Arch Canyon, 12 Oct 1988, *Baker 7640* (ORPI). †Alamo Canyon, leaves, involucres, fruits, 9570 ybp. †Puerto Blanco Mts, on ridge, leaves, fruits, 14,120 ybp.

TA: †Tinajas Altas, involucres, fruits, 8979 to 18,700 (9 samples), & >37,000 ybp.

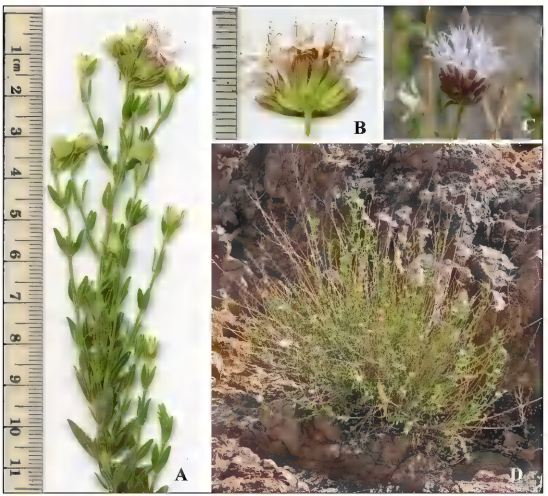

Figure 16. *Monardella arizonica*. (A & B) Bull Pasture Trail, Estes Canyon, 8 Sep 2014. (C & D) Boulder Canyon, 24 Sep 2007.

Salvia – Mint

Ephemerals, herbaceous perennials, and shrubs; mostly aromatic. Inflorescences of spikes, often interrupted (flower clusters separated by bare stem), the flowers in whorls (verticils), or in terminal head-like clusters. Corollas 2-lipped. Stamens 2, arching beneath the upper lip, often with an elongated connective (portion of filament connecting the anther sacs of a stamen), one of the anther sacs (pollen sacs) reduced. Worldwide; 900 species.

1. Winter-spring ephemerals.

2. Leaves mostly in a basal rosette and prominently pinnatifid; widespread. ..... **Salvia columbariae**
2. Leaves cauline (along the stems), not in a basal rosette, entire or shallowly toothed; rare..... **Salvia reflexa**

1. Robust herbaceous perennials, shrubs or subshrubs with leafy stems.

3. Inflorescences reaching 8 cm long; calyx not markedly glandular, the lobes blunt; corollas blue; Ajo Mountains..... **Salvia pinguifolia**
3. Inflorescences of spike-like panicles more than 20 cm long; calyx markedly glandular, the lobes spine-tipped; corollas white; mountains in Cabeza Prieta and the Goldwater Range ..... **Salvia vaseyi**

Salvia columbariae Bentham
Desert chia; *chía*; da:pk. Figure 17.

Winter-spring ephemerals, with mostly short, white hairs and sessile, golden to red-orange, globular glands especially dense on the lower leaf surfaces and calyces. Leaves mostly in basal rosettes, 4–9 (12) cm long, once or twice pinnatifid, the petioles prominent and narrowly winged, the stem leaves substantially reduced upward. Flowers in dense clusters (1.5) 2–4 cm wide, terminal and widely separated on leafless stems 5–35+ cm tall, the clusters appearing skewered on the flowering stems. Floral bracts nearly orbicular with spinescent tips. Calyx 9–12 mm long, the upper lip with a 2-pronged spinescent tip. Corollas dark blue. Nutlets ("seeds") smooth, flattened, about 2 mm long, mucilaginous when wet.

Widespread in Organ Pipe and Cabeza Prieta, mostly at lower elevations; washes, bajadas, sand flats, and dunes.

Arizona, California, Nevada, Utah, Baja California, and northwestern Sonora.

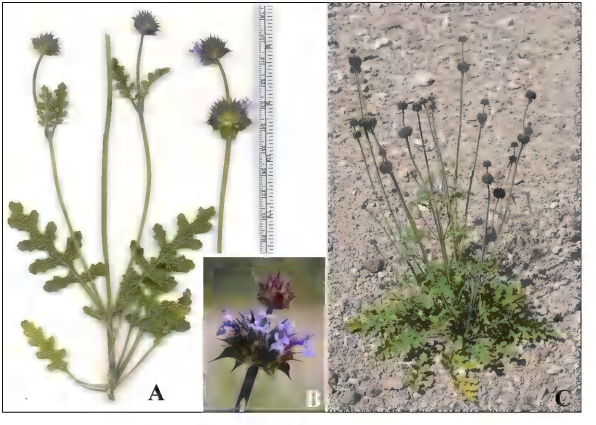

Figure 17. *Salvia columbariae*. (A) Estes Wash, 7 Mar 2008. (B) Chico Suni Wash near Chico Suni Village, 26 Feb 2005. (C) Headquarters Wash near Visitor Center, Organ Pipe, 15 Mar 2004.

The seeds were "much relished" by the Hia-Ced O'odham (Lumholtz 1912: 204) and by many others as a significant food resource in many regions of the Sonoran Desert (Felger 2007; Hodgson 2001). Placed in water, the seeds become gelatinous and were consumed as a beverage. The seeds were also parched and ground into flour, which was often stored. The seeds were also widely used medicinally, especially to treat eye irritants and ailments (Bean & Saubel 1972; Felger et al. 1992). Desert chia is sometimes cultivated.

OP: W of Bates Mts, 31 Mar 1978, *Bowers 1164*. Estes Canyon, 9 May 1979, *Bowers 1699*. Ajo Mountain Rd. (east loop), 6.5 mi NE of Hwy 85, 11 Mar 1983, *Daniel 2633* (ASU). Aguajita, 6 Apr 1988, *Felger 88-281*. Upstream from Bates Well, 1345 ft, 11 Mar 2003, *Felger 03-293*.
CP: Pinacate Lava flow (see Simmons 1966).

††**Salvia mohavensis** Greene
Mojave sage

Broad, compact small shrubs, with small glands and minute white hairs. Inflorescences of compact, head-like spikes with crowded bracts and blue flowers.

Widespread in the Sonoran Desert Region through the late Pleistocene, and part of the local flora from 9200 to more than 37,000 years ago. The nearest present-day occurrences are relictual populations at higher elevations in the Sierra Pinacate and the nearby Mohawk and Maricopa mountains. The present-day range is in the Mojave and Sonoran deserts in southeastern California, southern Nevada, western Arizona, and the Sierra Pinacate in Sonora.

OP: †Puerto Blanco Mts, on ridge, leaves, involucres, 10,540 & 14,120 ybp.
TA: †Butler Mts, twigs, leaves, 10,360 & 11,060 ybp. Tinajas Altas, leaf fragments, calyces, 9230 to 18,700, & > 37,000 ybp (12 samples).

Salvia pinguifolia (Fernald) Wooton & Standley
Rock sage. Figure 18.

Aromatic shrubs to about 1.5 m tall, the bark shredding. Stems slender and brittle. Herbage with minute unbranched hairs. Leaves petioled, the blades 2–5 cm long, mostly broadly triangular-ovate, often pale grayish green below, the margins toothed or scalloped. Inflorescences spike-like to 8 cm long. Flowers pedicelled. Calyx 7 mm long. Corollas blue, 12–15 mm long with a prominent lip; June to September.

Canyons and rocky slopes to the summit in the Ajo Mountains. It has been in the Ajo Mountains for 22,000 years and was in the Puerto Blanco Mountains 8000 years ago. It is no longer in the Puerto Blanco Mountains and no longer occurs at the Ajo Mountains midden site.

This salvia extends eastward and northward in southern and central Arizona to western Texas, and occurs in northern Sonora, northern Chihuahua, and Coahuila.

OP: Ajo Mts, *Nichol 3 Jun 1937*. W side of Alamo Canyon, 13 Sep 1941, *Goodding 299-41*. [Ajo Mts], base of ledges near summit, 28 Aug 1943, *Clark 10920* (ORPI). Canyon N of Alamo Canyon, 3500 ft, infrequent on rocky slope, 31 Mar 1948, *Darrow 3850*. Arch Canyon, shaded microsite below the arch, 2880 ft, 12 Sep 2013, *Rutman 20130912-20*. †Montezuma's Head, twigs, leaves, seeds, 14,500 & 21,840 ybp. †Puerto Blanco Mts, on ridge, fruits, 7970 ybp.

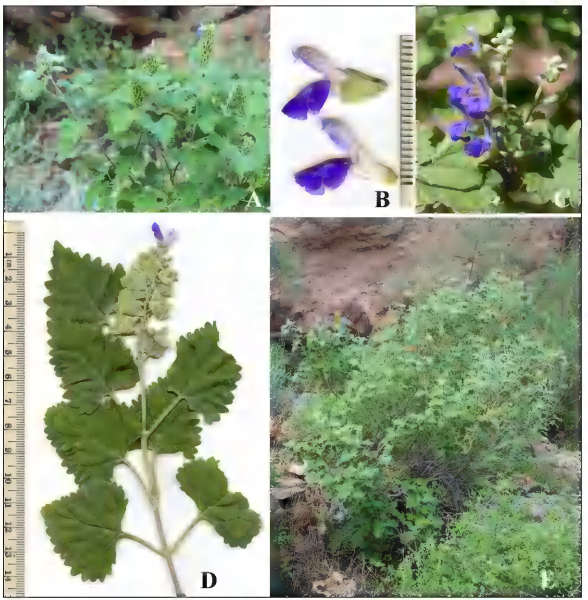

Figure 18. *Salvia pinguifolia*. (A, B, D & E) Bull Pasture Trail, Estes Canyon, 8 Sep 2014. (C) Arch Canyon, 16 Sep 2006.

****Salvia reflexa** Hornemann
Lance-leaf sage

Aromatic, rather delicate ephemerals; stems slender, 15+ cm in height. Stems leafy; leaves often 2–3 cm long, elliptic-oblong to narrowly lanceolate, the margins entire or shallowly toothed. Flowers mostly in pairs at distal nodes. Corollas about 1 cm long, pale whitish blue to blue, the Organ Pipe specimen recorded as having white corollas.

Known in the flora area from a single record at the Organ Pipe "campground" (near the park headquarters). Perhaps it was accidently introduced by a visitor, as with *Thlaspi arvense* (Brassicaceae) also known from a single collection at the same place and on the same date by Don Pinkava and associates. The nearest known records for this mint are in eastern and central Arizona.

This small mint is widespread in non-desert regions of North America and is often weedy.

OP: Campground, *Larrea* desert, flowers white, 25 Nov 1972, *Pinkava 9994* (ASU, det. D. Peppin, 26 Oct 2008).

Salvia vaseyi (Porter) Parish
[*Audibertia vaseyi* Porter]
Scallop-leaf sage. Figure 19.

Highly aromatic shrubs or sub-shrub perennials reaching 1+ m tall; facultatively drought deciduous and experiencing severe dieback in drought. Leaves mostly 2–9 cm long, petioled, and highly variable in size depending on soil moisture. Leaf blades mostly elliptic to ovate or oblong-ovate, pale green to whitish green; the margins scalloped with short, blunt teeth. The leaf blades are notably thick and the surfaces rugulose with prominently raised veins. Furthermore, the surfaces are covered by a dense tomentum of minute appressed hairs that impart a glaucous appearance (but not glaucous); these hairs often obscure the rugulose surfaces, filling the "valleys" between the raised veins (Walter Fertig, pers. comm. to Felger, 18 Jun 2015).

Inflorescences verticillate on tall, wand-like flowering stems; flowers in dense clusters or whorls at widely spaced intervals on the stem. Calyces 8–14 mm long, densely glandular, the lobes mostly awned, the awns becoming spinescent when dry at seed maturity. Corollas, filaments, and styles pure white. Corolla tube 13–20 mm long. Stamens and styles exerted. Fruits with light brown nutlets 2.5–3 mm long. Flowering spring and fall, depending on rains.

This unique mint was found in three local areas in the Sierra Pinta, each approximately 60 m in diameter and on steep granitic slopes with southwest exposures (Cain et al. 2010). The plants at the summit, at 816 m (2670 ft; *Cain & Jansen 21 Feb 2003*), were common but not abundant. The second site, on the lower slope of the mountain at 6 km north of the first locality, had 20–30 plants. The third site, near the base of the mountain at 405 m (1330 ft; *Cain & Jansen 21 Apr 2005*; Figure 19) and 5 km northwest of the first site, had fewer than 12 individual plants. On 8 March 2010, Jim Malusa found a population in the Copper Mountains on a north-facing slope about 120 m below the summit. The plants were common at this site. The Copper Mountains are about 28 km west-northwest of the Sierra Pinta.

Salvia vaseyi was previously known only from the west side of the Sonoran Desert in southern California and Baja California mountains near the California border. No morphological differences were found between Arizona and California specimens.

During extensive fieldwork over several years, Cain and Jansen did not find other *Salvia vaseyi* plants in the Sierra Pinta or to the west in the ecologically similar Cabeza Prieta Mountains, and Malusa reported that he did not find additional plants in the Copper Mountains or nearby similar mountains. Felger and others have conducted extensive fieldwork in other granitic mountains in southwestern Arizona and also have not found other *S. vaseyi* plants. Yet, due to the remote location of many southwestern Arizona mountains and restricted vehicle access in designated wilderness areas, there might be other localities where this or other previously undocumented species occur. *Salvia vaseyi* in Arizona seems to represent a relict population, most likely from a more extensive Ice Age distribution contiguous with the Californian populations. Similar Ice Age relict populations on either side of the Salton Trough are commonplace (e.g., Van Devender 1990, 2007, and Deep History in the Introduction to this flora series, Felger et al. 2013a).

There are five shrubby species of *Salvia* in Arizona: *S. dorrii* (Kellogg) Abrams complex (includes *S. pachyphylla* Epling ex Munz), *S. mohavensis*, *S. parryi* A. Gray, *S. pinguifolia*, and *S.*

vaseyi. Among these, *S. vaseyi* is most xeric-inhabiting species, has the narrowest ecological and geographic range, and can be distinguished by rugulose leaf blades with crenulate (scalloped) margins, bristle-tipped calyx teeth, and pure white flowers.

Figure 19. *Salvia vaseyi*. Sierra Pinta, ca. 2.7 mi NNW of Sunday Pass, 1330 ft, Yuma Co., 21 Apr 2005, photos by James W. Cain III.

CP: Top of Sierra Pinta, 0.5 mi S of Sunday Pass, 32.295100ºN, 113.560510ºW (WGS 84), 816 m (2670 ft), 12–18 inches tall, locally common among granite boulders, *Cain & Jansen 11 Feb 2003*. Sierra Pinta, 2.7 mi WNW of Sunday Pass, just S of Isla Pinta, 32.33719ºN, 113. 59921ºW (WGS 84), 405 m (1330 ft), *Cain 21 Apr 2005* (ARIZ, ASU, DES).

Barry M. Goldwater Range: Copper Mountains, ¼ mi E of summit, UTM E 218700, N 3599669 (WGS 84), 2480 ft, *Malusa 8 Mar 2010*.

Scutellaria – Skullcap

Perennial herbs and shrubs. Worldwide, mostly temperate; 360 species.

Scutellaria mexicana (Torrey) A.J. Paton

[*Salazaria mexicana* Torrey]

Bladder-sage. Figure 20.

Mound-like shrubs, reaching 1–1.5 m tall, the stems interlacing and branching at right angles. Twigs slender and brittle, often spinescent-tipped, with sparse foliage; pubescent with short, rather thick, and mostly appressed white hairs. Leaves quickly drought deciduous, sessile or short-petioled, the larger leaves 1–1.8+ cm long, lanceolate to ovate or elliptic; margins entire. Inflorescences racemose. Flowering calyx often dark rose, about half as long as the flower, the fruiting calyx enlarging to become globose and inflated like a balloon or paper bag, 15–20 mm long. Corollas 16–22 mm long, 2-lipped, lobes of upper lip dark blue, the lower lip white with purple-blue nectar guides. Stamens 4. Massive flowering at various seasons following rains.

Figure 20. *Scutellaria mexicana*. (A & D) Joshua Tree National Park, 30 Apr 2012. (B & C) Tinajas Altas, 2 Mar 2014, photos by Sue Carnahan.

Cabeza Prieta and Tinajas Altas on steep rocky slopes, especially north-facing exposures at higher elevations, canyons, and upper bajadas; and one record from Organ Pipe near the top of Bates Mountain.

Deserts in western Arizona, southeastern California, southwestern Utah, both states of Baja California, and northwestern Sonora, and disjunct in Texas, Chihuahua, and Coahuila.

Molecular data indicates *Salazaria* should be included with *Scutellaria* (Paton 1990; Wagstaff et al. 1998). Morphologically, however, *Salazaria* is distinctive in being a woody-based shrub rather than herbaceous, having reduced leaves, green (cladophyllous) and somewhat thorny stems, resupinate ("upside down") flowers, and an unusual inflated calyx enveloping the fruit. Otherwise the flower structure, anthers, and fruits are similar to those of *Scutellaria* (James Henrickson, pers. comm. to Felger, 2010).

OP: Saddle just N of Kino Peak, *Wilson 9 Apr 1993* (ORPI).

CP: Heart Tank, *Simmons 16 Mar 1963* (CAB). N side of Tule Mts, 2 Feb 1992, *Felger 92-51*. Salazaria Wash, 12 Apr 1992, *Harlan 250* (CAB). Canyon at Agua Dulce Tank, 13 Jun 1992, *Felger* (observation). Growler Mts, vicinity of Growler Peak, just N of Charlie Bell Pass, 302813 E, 3588012 N, *Peter Holm 4 Apr 2014*.

TA: Tinajas Altas, canyon bottom, 1000 ft, 28 Oct 1937, *Gentry 3524*. Tinajas Altas Mts, Camino del Diablo, canyon bottom in upper canyon, 0.4 km SW from the uppermost of tinaja, 26 Nov 2004, *Felger 04-90*.

Tetraclea

Perennial herbs, 2 species; southwest U.S. and Mexico.

Although *Tetraclea* has been treated as part of *Clerodendrum*, that genus in the broad sense is polyphyletic, leading to restored recognition of *Tetraclea* (Yuan et al. 2010). *Clerodendrum* sensu lato with 150 species is worldwide in temperate to mostly tropical regions; following Yuan et al. (2010) a monophyletic *Clerodendrum* is restricted to the Old World.

Tetraclea coulteri A. Gray
[*Clerodendrum coulteri* (A. Gray) Govaerts]
Coulter's wrinkle-fruit. Figure 21.

Foul-smelling, herbaceous perennials, rhizomatous and often forming clonal colonies. Plants with small, recurved, white hairs. Stems 4-angled, slender, leafy, and upright, to 40 cm long. Leaves 1.5–3.5 (5.5) cm long; petioles winged, 4–10 mm long; leaf blades mostly ovate to lanceolate-ovate, tending to be entire on lower (larger) leaves and coarsely toothed on upper leaves. Inflorescences of 1–4-flowered axillary clusters sometimes nearly throughout the plant. Calyx deeply 5-parted, enlarging in fruit. Corollas with a pinkish tube and 4 or 5 broad, white lobes. Stamens 4, long exserted. Style about as long as the stamens and 2-branched at the tip. Fruits of 4 nutlets (or 2 by abortion). Growing with hot weather and flowering at least after summer-fall rains.

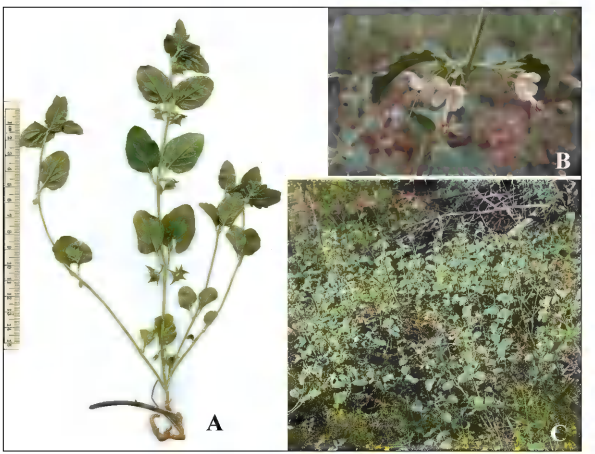

Figure 21. *Tetraclea coulteri*. (A) Midway Tank, between Ajo and Why, 31 Aug 2014. (B) Salero Ranch, Santa Cruz Co., 14 Aug 2011, photo by Sue Carnahan. (C) Small drainage near the Bates Well Road, N of Bates Mts, 4 Aug 2014.

Widely scattered and apparently highly localized in low elevation areas of Organ Pipe and the east side of Cabeza Prieta; mostly in areas where water settles on sandy and loamy soils, especially in shaded or partial shaded niches. Sometimes also in rocky areas, such as the Diablo Mountains near Ajo Mountain Drive and along the Bates Well Road, but growing in deposits of fine soils along drainages. *Tetraclea coulteri* and *Phacelia pedicellata* are the stinkiest plants in the flora area.

Southern Arizona to western Texas and the Chihuahuan Desert Region to Puebla, and a few localities in northern Sonora including a 1941 record west of Hermosillo (*Wiggins & Rollins 179*).

OP: 2 mi SE of Walls Well, near N end of Ajo Mts, banks of broad sandy wash, 30 Aug 1945 *Haskell 3219*. 1.5 mi E of Blankenship Ranch, *Rutman 24 Nov 1997* (ORPI). Near Pozo Nuevo–Bates Well Road junction, *Rutman 23 Aug 2001* (ORPI). 3 mi E of Dos Lomitas along border road, *Rutman 29 Aug 2001* (ORPI). Valley of the Ajo, xeroriparian, sandy-loam soil, *Wirt 9 Sep 2003*. Cuerda de Leña Wash, 0.5 mi S of Organ Pipe north boundary, rare, shaded loamy bank above scour line, 7 Oct 2006, *Rutman 20061007-16*.

CP: Camino del Diablo 2.4 mi SW of E Refuge boundary, roadside in sand soil, 15 Sep 1992, *Felger 92-741*. San Cristobal Wash at Camino del Diablo, 26 Sep 2013, *Rutman 20130926-10*.

Teucrium

Ephemerals or perennial herbs with square stems. Corollas seemingly with only a lower lip, the middle lobe enlarged and often elongated, the pair of smaller lateral lobes derived from part of the upper lip. Stamens 4. Worldwide; 250 species.

1. Ephemerals, pubescent at least on upper part of plant; corollas to 11 mm long, blue to nearly white..... **Teucrium cubense**
1. Perennials, essentially glabrous except for pedicels and a few hairs on newest growth and corollas; corollas more than 15 mm long, white or whitish and often with lavender nectar guides. ..... **Teucrium glandulosum**

Teucrium cubense Jacquin subsp. **depressum** (Small) E.M. McClintock & Epling
Dwarf germander. Figure 22.

Non-seasonal ephemerals, the stems 8–45 cm long, soon spreading to ascending-decumbent. Herbage and inflorescences glandular, the inflorescences and sometimes the new herbage with coarse, white, curly to crinkled hairs. Leaves 3–8 cm long, variously lobed or incised; lower leaves broader and not as deeply cut as upper leaves, the upper leaves with fewer but larger lobes. Flowers in leafy-bracted terminal racemes. Pedicels (0.8) 2–8 mm long. Calyx 4.5–6.5 (7) mm long, deeply parted into prominent teeth. Corollas pale blue to nearly white, 8–11 mm long. Nutlets 2.2–2.5 mm long, somewhat obovoid, glandular, with short bristly hairs on reticulate ridges.

Localized in fine-textured soils in low lying, seasonally wet and often poorly drained habitats including swales in mesquite floodplains, areas of overland flood flow, playas, wet to damp mud at the margins of dirt tanks (charcos), roadside depressions, and sometimes in canyon bottoms; often locally abundant.

Southeastern California to western Texas, and northwestern and north-central Mexico. This species, with 5 subspecies, extends to southeastern USA, the Caribbean, and southern South America.

OP: Alamo Canyon, 2 Apr 1944, *Clark 11669* (UNM). Dos Lomitas, *Wirt 12 Apr 1989*. Impoundment of earthen embankment, Hwy 85 at 0.7 mi S of N boundary of Monument, *Rutman 2 Apr 1998* (ORPI). Kuakatch Wash near village of Kuakatch, just W of E boundary of Organ Pipe, shaded bank of wash, 24 Mar 2013, *Rutman 20130324-1*.

CP: Jose Juan Tank, 26 Feb 1993, *Felger 93-99*. Agua Dulce Mts, 1075 ft, *Schmidt 7 Jan 1997*. San Cristobal Wash, N boundary of Refuge, *Malusa 18 Apr 2001*. Las Playas, 28 Nov 2001, *Felger 01-570*.

Figure 22. *Teucrium cubense* subsp. *depressum*. Pinacate Junction, Pinacate Biosphere Reserve, Sonora: (A) 8 Feb 2015; (D) 28 Mar 2013. (B & C) Wildlife charco E of Hwy 85 near mile 58, 7 Feb 2014.

Teucrium glandulosum Kellogg
Desert germander. Figure 23.

Herbaceous perennials, somewhat bushy and sometimes dying back severely in drought, commonly 40–75 cm tall including inflorescences. Stems slender and brittle, mostly erect from a much-branched caudex. Leaves and calyx surfaces glandular-punctate with glistening golden glands. Leaves gradually drought deciduous, (1.6) 2.3–6 cm long, sessile, mostly lanceolate; lower leaves sometimes with 1–3 prominent teeth on each side, the larger leaves with a pair of large lobes; upper stem leaves reduced and usually entire. Flowers relatively large and attractive, in racemes (13) 18–50 cm long. Youngest herbage, buds, and corollas with a few scattered hairs. Pedicels (7) 9–27 mm long, longest in the lower part of the inflorescences, glandular and also with short white hairs. Calyx 5–8 mm long, deeply parted into prominent teeth. Corollas 18–26 mm long, white with pale purple nectar guides, or sometimes all white. Nutlets 3–3.4 mm long, oval, glandular, and hairy at the tip. Flowering at least spring and fall.

Shaded canyon bottoms in at least several mountain ranges in Cabeza Prieta, one record in Organ Pipe, and Coyote Wash in the Tinajas Altas Region, but probably more widespread.

In the USA known otherwise only from the Castle Dome Mountains in western Arizona and a few locations in California. Also northwestern Sonora and both Baja California states. This is one of the few species in this large genus confined to a desert.

OP: High-angle bedrock drainage to the NW of Kino Peak, 2000 ft, under dry waterfall and protected from scour, single plant seen, 31 Mar 2005, *Rutman 20050320-39*.

CP: Cabeza Prieta Tanks, *Simmons 26 Oct 1962*. Eagle Tank, 13 Jun 1992, *Felger 92-586*. Heart Tank, 27 Feb 1993, *Felger 93-156*. Buck Peak, 1700 ft, *Jansen 24 May 2005*.

TA: Coyote Wash at Camino del Diablo, clay-like soil in dense mesquite brush, 10 Jan 2002, *Felger 02-14*.

Figure 23. *Teucrium glandulosum*. (A) SW Copper Mountains, 2.1 km S of Coyote Peak, Yuma Co., 22 Oct 1993, *Schulz 402* (ASU, SEINet). (B) Photo by David Sussman (SEINet).

LINACEAE – Flax Family

Annual and perennial herbs, vines, trees, and shrub. Worldwide; 12 genera, 300 species.

Linum

Mostly Eurasia and North America; 180 species.

***Linum bienne** Miller

Pale flax. Figure 24.

Spring ephemerals (elsewhere perennial herbs) with upright stems to about 50 cm tall; glabrous. Leaves alternate, held upright close to the stem, sessile, about 1–2 cm long, linear to narrowly lanceolate, the margins entire. Flowers 5-merous and radially symmetric, on slender

pedicels. Corollas pale blue; petals 5, each 10–15 mm long, broadly obovate. Fruits of broadly ovate capsules, 5–7 mm long, seeds gelatinous when wet. Flowering March and April.

Figure 24. *Linum bienne*. (A & B) Hwy 85 near mile marker 70, 26 Feb 2005. (C) Deer Creek Center, Selma, Josephine Co., OR, 17 May 2007, photo © by Keir Morse (CalPhotos).

Occasional and widely scattered in Organ Pipe, but not in the southern margin and southwestern portion of the Monument; bajadas, rocky slopes, arroyos, and roadsides.

Native to the Mediterranean region and western Europe; naturalized in western North America and elsewhere. *Linum bienne* is the probable ancestor of the cultivated flax, *L. usitatissimum*. *Linum bienne* is locally common in some areas in southern Arizona. It is often confused with the native *L. lewisii* Pursh. They can be distinguished as follows:

1. Plants upright; margins of inner sepals minutely ciliate or toothed; corollas pale blue; stigmas linear to club-shaped..... **Linum bienne**
1. Plants slightly spreading; margins of inner sepals entire; corollas blue (not pale); stigmas rounded..... **Linum lewisii**

OP: Near Cherioni Well, *McDougall 9 Apr 1941*. Wash, *Waldon 18 Apr 1964* (ASU). N of headquarters, bajada, *Ranzoni 26 Mar 1965* (ORPI). Puerto Blanco Drive, *Beale 2 Mar 1986* (ORPI).

LOASACEAE – Stickleaf Family

Ephemerals, herbaceous perennials, and shrubs. Hairs silicified or calcified, barbed (usually glochidiate—barbs in whorls), needle-like, or gland-tipped. Leaves alternate (those in the flora area) and simple; stipules none. Flowers radial. Sepals 5, persistent; petals separate or united, 5 (or

seemingly 10 including staminodes). Stamens 5 to many, the filaments narrow or petal-like in the outermost whorls. Ovary inferior, the style 1. Fruits dry, dehiscent and multiple-seeded or indehiscent and 1-seeded.

Mostly in the Americas; 14 genera, 265 species.

1. Perennials; flowers white; stamens 5; fruits 1-seeded and indehiscent..... **Petalonyx**
1. Ephemerals (short-lived perennials in *Mentzelia puberula*); flowers green, yellow, orange, or whitish; stamens 10 or more; fruits many-seeded.

2. Stems and petioles thickened and succulent or semi-succulent; leaf blades as wide as or wider than long, the upper surface glistening; corollas tubular, yellowish with green lobes..... **Eucnide**
2. Stems and petioles not succulent; leaf blades mostly longer than wide, the surfaces dull; corollas whitish, yellow, or orange, not tubular..... **Mentzelia**

Eucnide

Annuals (or subshrubs elsewhere). Southwestern USA to Guatemala; 14 species. The three species of the genus *Sympetaleia* were placed in *Eucnide* section *Sympetaleia* by Thompson and Ernst (1967). These three species are ephemerals/annuals confined to the Sonoran Desert Region surrounding the Gulf of California. Unlike other *Eucnide*, the three *Sympetaleia* do not having stinging hairs (e.g., Wiggins 1964).

Eucnide rupestris (Baillon) H.J. Thompson & W.R. Ernst
[*Sympetaleia rupestris* (Baillon) A. Gray ex S. Watson]
Velcro plant, rock nettle. Figure 25.

Figure 25. *Eucnide rupestris*. (A) Bahía San Pedro, Sonora, 5 Feb 2015, photo by Sue Carnahan. Lava flow and cinders near Red Cone trailhead, Pinacate Biosphere Reserve, 3 Mar 2009: (B) Flowering branch; (C) Portion of margin of a calyx lobe.

Non-seasonal ephemerals, the roots unusually small relative to plant size. Herbage, inflorescences, ovaries, and calyx bases with stout, glassy hairs, the larger hairs smooth and needle-like, the shorter hairs with a terminal whorl of barbs like miniature grappling hooks, causing pieces of the plant to stick like Velcro. Leaf blades 3–7 cm wide, nearly rounded or cordate at the base, broadly toothed to shallowly lobed, relatively thin and bright yellow-green, the upper surfaces glistening. Flowers about 1.5–2 cm long; calyx lobes yellow; corollas dull yellow and tubular below, the lobes short, bright green, and scarcely or not spreading. Fruits opening terminally by valves. Seeds minute, numerous.

Locally common in the vicinity of Cabeza Prieta Tanks where it grows on crevices of canyon cliffs, and along sandy-gravelly washes. Three additional records known from the flora area, although we expect it to occur in other scattered localities.

In the USA known otherwise only from southeastern California where it is rare. Common in northwestern Mexico near the USA border southward to northwestern Sinaloa, Baja California and Baja California Sur, and Gulf of California islands.

OP: Rancho Bonito, La Abra Valley, 9 Dec 1939, *Harbison 26214* (RSA, SD). Bates Mts, Kino Peak along trail at large NNE-facing cliff below peak, 2900 ft, *Wirt 5 Dec 1990*.

CP: Cabeza Prieta Tanks, 4 Feb 1959, *Monson 1*. Growler Mts, vicinity of Growler Peak, just N of Charlie Bell Pass, 302650 E, 3587997 N, *Peter Holm 4 Apr 2014*.

Mentzelia – Stickleaf, blazing star; *pegapega*

Spring or summer ephemerals or longer-lived annuals, or short-lived perennials (herbaceous perennials to shrubs elsewhere and one tree in the tropics). Stems often with peeling, whitish epidermis. Hairs barbed (glochidiate), the plants adhesive, especially the leaves and capsules (fresh leaf pieces stick on clothing like Velcro). For many or most mentzelias there is a transition from basal-rosette leaves to the bracts on the upper stems: leaves all sessile, or basal-rosette leaves and sometimes a few of the lower stem leaves are petioled, whereas upwards there is a gradation to smaller, sessile, and even clasping leaves or bracts. Flowers solitary and axillary or in terminal cymes usually with bracts. Petals 5 (or seemingly 10 including staminodes), deciduous, yellow or orange to whitish. Stamens 10 to many, the filaments slender, or outer stamens sometimes with broad, petal-like (petaloid) filaments or forming petaloid staminodes. Fruits of capsules, opening by 3 valves at the tip. Seeds few to many, variously sculptured, angled, prismatic, flattened, and/or winged.

Western North America to South America including the Atacama Desert; 120 species.

Sonoran Desert mentzelias can be grouped into four easily recognized sections and several species groups (see key to the species; Christy 1998). The flowers are usually closed during midday. Among the members of sections *Mentzelia* and *Trachyphytum* the flowers open in the morning, in section *Bartonia* the flowers open in the late afternoon, and in section *Bicuspidaria* the flowers are open in both morning and afternoon.

Among the members of section *Mentzelia*, and probably section *Trachyphytum*, some are obligately selfing (autogamous) and others are not, but in the flora area they are probably at least facultatively selfing. As might be expected, the smaller-flowered taxa with higher ploidy levels are self-compatible but not obligately selfing.

1. Stems including the main shoot notably slender; petals usually less than 8 mm long; flowers and capsules sessile; capsules narrowly cylindrical, sometimes gradually and slightly expanded above, and more than 5 times longer than wide.

2. Stems conspicuously pubescent and rough to the touch (scabrous-hispid); leaves petioled, lower leaves usually hastately lobed (large-lobed at the base); seeds clearly longer than wide. ..... sect. **Mentzelia**: **M. isolata**
2. Stems minutely pubescent (may appear glabrous without magnification) and smooth to the touch; stem (cauline) leaves sessile, lobed but not hastate; seeds about as wide as long. ..... sect. **Trachyphytum**

3. Capsules linear, straight (not curved) and not narrowed at the base; seeds in a single row in capsules, all precisely prismatic (3-sided prisms) and sharply angled, conspicuously and regularly grooved along the 3 longitudinal edges, the ends truncate (flat, as if sliced in cross-section), the surfaces smooth. ..... **Mentzelia affinis**
3. Capsules linear but slightly narrowed towards the base and often curved; seeds in 2 or more rows towards the apex (1 row at base), angular or not, at least those toward apex (tip) of fruit not precisely prismatic, not grooved on all 3 sides or if grooved on all 3 sides then the 3 "corners" not all the same shape (caution: seeds at base of capsules sometimes prismatic as in *M. affinis*)..... **Mentzelia desertorum**

1. Stems of main shoot not especially slender; petals usually more than 8 mm long; flowers and capsules pedicelled; capsules to about 2 times longer than wide, not narrowly cylindrical.

4. Bracts 1.5–3 cm long, ovate to elliptic, with white area at base, the margins with slender lobes; petals silvery; seeds not winged..... sect. **Bicuspidaria**: **Mentzelia involucrata**
4. Bracts less than 1.3 cm long, linear to linear-triangular, all green and entire; petals and petal-like filaments bright yellow; seeds winged..... sect. **Bartonia**

5. Caudex often thickened but lower stems not woody; larger leaves (5.5) 9–15 cm long, in a basal rosette; petals seemingly 10; seeds 3.3–4 mm long..... **Mentzelia longiloba**
5. Lower stems often woody like a dwarf shrub; larger leaves (1.8) 2.5–6.5 cm long, on the stems (cauline; the basal rosette very quickly withering in first season); petals 5 (the larger staminodes petal-like but clearly narrower than the petals); seeds 2.4–3.1 mm long. ..... **Mentzelia puberula**

Mentzelia affinis Greene
Triangle-seed blazing star; *pegapega*. Figure 26.

Spring ephemerals. Stems very slender, at first minutely pubescent (visible at 10× magnification), becoming glabrate and shiny white with age. Leaves sessile, highly variable, the lower leaves more or less narrowly elliptic to lanceolate, deeply and irregularly lobed, the upper leaves few-toothed to entire and sometimes broadly ovate. Bracts green throughout, variable, ovate to lanceolate, entire to lobed, shorter than the capsules. Flowers opening in the early morning, closing later the same morning, and apparently opening again the next day. Petals 5, small and bright yellow. Filaments all slender. Capsules sessile, slender and triangular in cross-section, not narrowed at the base, straight or curved, 11–15 × 1.5 mm. Seeds 0.9–1.3 mm wide, about as wide as long, in a single row in the capsule, angular, prismatic, conspicuously 3-angled and grooved along each angle, the ends abruptly truncate (flat and smooth as if sliced in cross sections); mottled and smooth in appearance with flat-topped papillae.

Widespread across the flora area, mostly on sandy soils in washes and flats.

Southern, central, and northwestern Arizona, northern Sonora, Baja California, southern California, and Nevada.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. NW corner of Monument, 21 Mar 1941, *McDougall 6*. W of Bates Mts, 31 Mar 1978, *Bowers 1170*. Aguajita, 6 Apr 1988, *Felger 88-287*.

CP: 4.7 mi NE of Tule Well, 28 Mar 1985, *McLaughlin 2976*. 1.7 mi E of W Refuge boundary on Camino del Diablo, 16 Jun 1992, *Felger 92-620*. E Pinta Sands, 11 Apr 1993, *Felger 93-429*.

Figure 26. *Mentzelia affinis*. Mohawk Dunes, Yuma Co., 3 Mar 2014, photos by Sue Carnahan.

Mentzelia affinis and *M. desertorum*, members of section *Trachyphytum*, have slender stems throughout, small yellow or orange flowers, no petaloid staminodes, and narrow capsules. The petals tend to elongate with age, so that petal shape on the first day may be ovate but become lanceolate with age. Petal size may be of taxonomic significance, but is usually not discernable on herbarium specimens. Seeds at the base of the capsule tend to be triangular prisms with a longitudinal groove along each angle. The capsule is so narrow at its base that seed shape is largely the result of the developing seed(s) being confined between the walls of the triangular capsules. The grooves along the seed angles are formed by the placenta pressing against the seeds while they are still plastic and developing. In *M. affinis,* with its very slender capsules and seeds in a single row (like a stack of coins), all the seeds are triangular prisms. In M. *desertorum* only the lowermost seeds are triangular prisms (or at least a somewhat different shape than the upper seeds). For this reason it is important to look at seeds toward the apex of the capsule; unfortunately these seeds tend to fall out of mature capsules. Immature seeds are often more or less the same shape as mature seeds, but the surface sculpturing is not yet developed. When soaked in water the seeds swell to become spherical.

Mentzelia desertorum (Davidson) H.J. Thompson & J.E. Roberts
Figure 27.

Spring ephemerals. Stems whitish, slender, minutely pubescent, with age whiter and glabrate. Leaves sessile, highly variable, to about 12 cm long, linear to narrowly elliptic or lanceolate, margins variously lobed or toothed; first leaves in a basal rosette, stem leaves reduced above. Floral bracts lanceolate to broadly ovate to narrowly or broadly triangular, uniformly green, entire to few-toothed. Flowers sessile, opening in the early morning, closing later in the same morning, and apparently opening again the next day. Petals often 3–5 mm long, bright yellow, sometimes with a dark orange or reddish spot at the base. Stamens many, filaments slender, staminodes none. Capsules mostly 15–30 × 1.3–2 mm, sessile, cylindrical-triangular, gradually and slightly wider at the tip, curved downward 90° or more at maturity, especially those in stem axils. Seeds 0.8–1.2 mm in width and length, not winged, in 2 or more rows toward the capsule apex, variously concave or convex, the edges (angles) rounded, the seed surfaces flat, with a few dark papillae.

Figure 27. *Mentzelia desertorum*. (A) Midway Wash at Hwy 85, 8 Mar 2015. (B & C) Mohawk Dunes, Yuma Co., 3 Mar 2014, photos by Sue Carnahan.

Western part of Cabeza Prieta on sandy soils of washes and desert flats, and especially common on sand flats and dunes of the Pinacate lava area, Pinta Sands, and the nearby Gran Desierto in Sonora.

Mentzelia desertorum occurs in the core area of the Sonoran Desert: southeastern California, western Arizona, northeastern Baja California, and northwestern Sonora. *Mentzelia desertorum* and *M. albicaulis* are similar appearing plants with allopatric distributions; *M. albicaulis* does not occur in the core area of the Sonoran Desert. Brokaw and Hufford (2010) found *M. desertorum* to be distantly related to *M. albicaulis*.

CP: Papago Well, *Crooks 31 Mar 1937* (ARIZ 83230, det. Charlotte M. Christy 1995). Papago Wells [sic], sand dunes, *Crooks 31 Mar 1937* (ARIZ 83231, det. C.M. Christy 1995). W end of Pinacate Lava flow, 800 ft, uncommon on sandy flats, *Larrea, Hilaria*, 29 Mar 1985, *McLaughlin 2986* (ARIZ 257592, det. Barry A. Prigge 1989).

TA: Tinajas Altas Mts, W end of Pass just N of Tinajas Altas Pass, 1080 ft, in wash, *Van Devender 6 Mar 1983* (ARIZ 240826, det. C.M. Christy 1995). Butler Mts, 780 ft, sand dune, *Van Devender 27 Mar 1983* (ARIZ 240825, det. C.M. Christy 1995).

Mentzelia involucrata S. Watson
[*M. involucrata* var. *megalantha* I.M. Johnston]
Silver blazing star; *pegapega*. Figure 28.

Winter-spring ephemerals. Stems relatively stout, branching from the base, shiny white, hairy (scabrous-hispid), not peeling. Leaves sessile, narrowly lanceolate to elliptic, coarsely toothed to

pinnatifid, the lower ones (3) 5–18 cm long. Bracts 1.5–3 cm long, with a broad whitish membranous center, green margins, and several slender pectinate lobes. Flowers pedicelled. Calyx lobes 8–16 mm long. This is the largest-flowered mentzelia in the region, with petals 2–3.7 cm long, satiny silvery white to pale yellow with orange veins. Outer filaments expanded toward the tip into 3 teeth, the anther on the middle tooth. Capsules 1.5–2.2 cm long. Seeds often 3–3.5 mm long, thick but flattened, ovoid, not winged, whitish and usually constricted in the middle (equatorially). Drought-stressed plants can be quite small with proportionally smaller parts.

Widely scattered across Organ Pipe and most of Cabeza Prieta.

Western and central Arizona, northwestern Sonora, southeastern California, and Baja California.

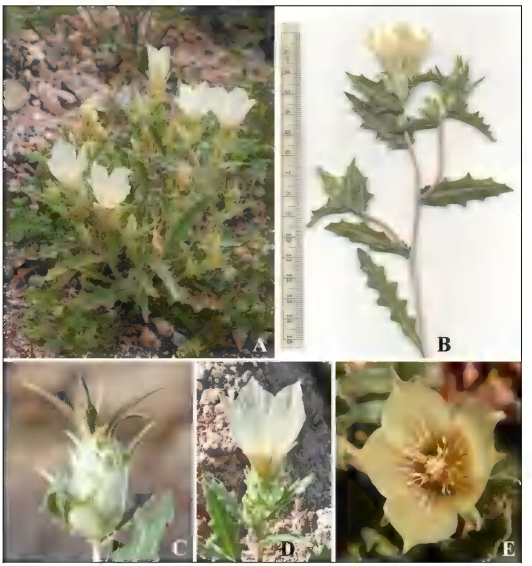

Figure 28. *Mentzelia involucrata*. N foothills of Puerto Blanco Mts, North Puerto Blanco Drive: (A) 5 Mar 2005; (E) 10 Mar 2008. (B) Ajo Scenic Loop Drive, S of Ajo, 26 Mar 2014. (C) Lookout Mountain, N of Ajo, 2 Mar 2014. (D) Near campground at Red Cone, Pinacate Biosphere Reserve, Sonora, 29 Feb 2008.

OP: Quitobaquito, *Clark 25 Mar 1944* (ORPI). Growler Mts, foothills, 16 Apr 1952, *Parker 7970*. 13.4 mi by road NW of Visitor Center, Puerto Blanco Drive, 10 May 1979, *Bowers 1715*.

CP: Sheep Tanks, 28 Mar 1935, *Kearney & Peebles 11012*. 7 mi by road E of Papago Well, 18 Feb 1979, *Bowers 1573*. 3.8 mi N of Tule Well, Cabeza Prieta Mts, 9 Mar 1986, *Van Devender 86-17*. Pinacate Lava, 21 Mar 1992, *Harlan 66* (CAB).

Mentzelia isolata Gentry
Figure 29.

Summer ephemerals with slender stems. Leaves petiolate; blades 2–14 cm long, sometimes exceptionally large following ample rain, ovate to lanceolate, often with 1 or 2 pairs of basal lobes, the lower (basal) leaves often with elliptic blades. Flowers and fruits sessile. Sepals usually persistent. Petals 5–7 mm long, orange. Staminodes none, although outer stems with slightly broadened filaments. Capsules 2–3 cm long, slender, tapering to the base. Seeds angled, not winged, appearing in one row.

Known from higher elevation in the Ajo and Diablo mountains and Dripping Springs in the Puerto Blanco Mountains.

Eastward in Arizona to Cochise County and southward to Sinaloa.

OP: Above Dripping Springs, *Supernaugh 27 Oct 1951* (ORPI). Bull Pasture, *Wirt 13 Aug 1990*. Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-22*.

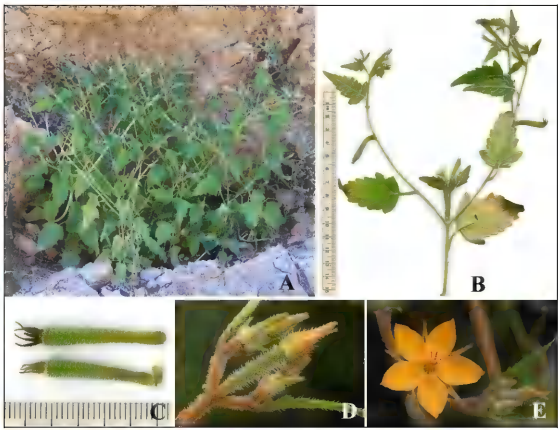

Figure 29. *Mentzelia isolata*. (A) Bull Pasture, 25 Sep 2013. (B & C) Trail to Bull Pasture, 8 Sep 2014. (D & E) Portal-Paradise Road, Chiricahua Mts, Cochise Co., 2 Jul 2006, photos by Patrick Alexander (SEINet).

Mentzelia longiloba J. Darlington var. **longiloba**
[*M. multiflora* (Nuttall) A. Gray subsp. *longiloba* (J. Darlington) Felger]
Blazing star; *pegapega*. Figure 30.

Robust winter-spring ephemerals or perhaps sometimes short-lived perennials (often perennial elsewhere); stems few to many, often 40–75 cm tall, white with barbed short hairs. Leaves

sessile, narrowly lanceolate to oblanceolate and pinnately lobed to parted, first ones in basal rosettes, (5.5) 9–15 cm long, the stems leaves reduced above. Flowers pedicelled, in terminal corymbs, several per cluster. Bracts linear to linear-triangular, 8–12 mm long. Calyx lobes 8–13 mm long. Petals bright yellow, often with orange stripes, seemingly 10 (the 5 inner ones staminodes with anthers at apex), larger petals 12–26 cm long. Stamens bright yellow, numerous; inner filaments slender, the outer filaments broadly winged and grading into the petals. Capsules 1–2 × 0.8–1 cm. Seeds numerous, 3.3–4 mm long, the body flat, light brown, surrounded by whitish wings that become transparent when wet.

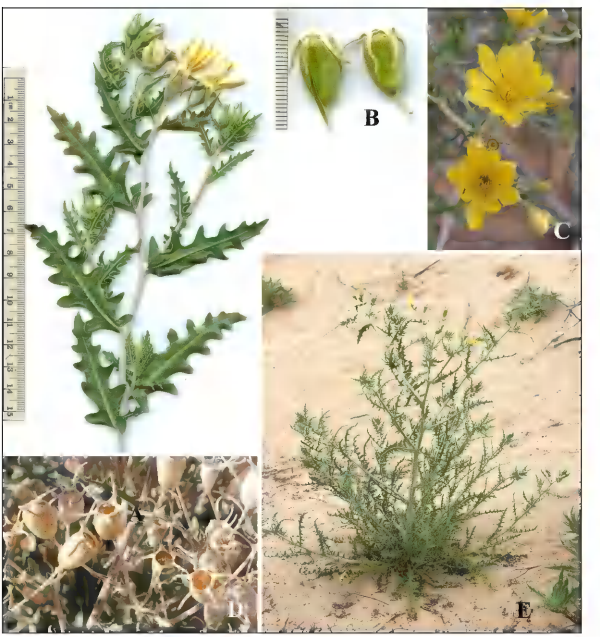

Figure 30. *Mentzelia longiloba* var. *longiloba*. (A & B) Ajo Way at La Cholla, Tucson, 28 Sep 2014. (C) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 20 Feb 2005. (D) Pinta Sands, 11 Feb 2014. (E) Dunes near Mayan Palace, about 25 miles SE of Puerto Peñasco, Sonora, 20 Feb 2015.

Sand flats and dunes in Cabeza Prieta, especially the Pinta Sands, scattered in Organ Pipe, mostly in gravelly-sandy washes and canyon bottoms, and canyon washes in the Tinajas Altas Mountains.

This species, with three varieties, ranges from southern California to Utah and west Texas, and northern Mexico from Baja California to Coahuila. Var. *longiloba* is the most widespread of the

three, occurring from southeastern California to Utah and west Texas and adjacent northern Mexico (Schenk & Hufford 2010). *Mentzelia longiloba* var. *pinacatensis* J.J. Schenk & L. Hufford occurs in Sonora just south of the flora area and might be found in adjacent borderlands of the flora area, especially the Tinajas Altas Region.

The seeds of this species and at least some others were parched and ground and the flour consumed as gruel. The seeds are available mostly mid- to late spring. There is no direct evidence of use in the flora area, but the seeds were widely used elsewhere, including southern California (Bean & Saubel 1972) and have been recovered from archaeological caches (Hodgson 2001).

OP: Rancho Bonito, La Abra Valley, 9 Dec 1939, *Harbison 26217*. Alamo Canyon, *Tinkham 15 Apr 1942*.

CP: Pinta Sands: 21 Mar 1979, *Yatskievych 79-242*; 11 Jan 2002, *Felger 02-26* (det. John J. Schenk, Dec 2009). W edge of Pinacate lava flow, 800 ft, sandy flats, *Larrea, Hilaria*, 29 Mar 1985, *McLaughlin 2985* (det. John J. Schenk, Dec 2009). 0.5 mi S of Sunday Pass, *Cain 15 Nov 2003* (det. John J. Schenk, Dec 2009).

TA: Frontera Canyon, 18 Mar 1998, *Felger* (observation, variety uncertain).

Mentzelia puberula J. Darlington
Argus blazing star. Figure 31.

Short-lived perennials often 30–60 cm tall, with stems branching throughout, sometimes like dwarf shrubs with woody lower stems. Stems whitish and leafy; leaves (1.8) 2.5–6.5 cm long, mostly dull gray-green, more or less ovate-lanceolate to elliptic or obovate, coarsely toothed to shallowly lobed, the uppermost leaves sessile, the lower ones gradually narrowed basally. Bracts linear. Flowering spring and summer depending on rains, the flowers opening in the late afternoon. Petals and stamens bright yellow on interior surfaces, pale on backs, the petals 5 in number, 10–13 mm long, rounded at tip. Inner filaments slender, the outer filaments broadened (petaloid) and grading into the petals but clearly narrower than the 5 petals. Capsules 5–9 mm long, rounded at the base. Seeds many, horizontal in the capsules, 2.4–3.1 mm long, conspicuously winged, papery and white when dry, the wings transparent when wet and the body

Figure 31. *Mentzelia puberula*. Chocolate Mts, Imperial Co., CA, 7 Mar 2011, photos © by Duncan Bell (CalPhotos).

Found in widely scattered localities in the flora area, especially at higher elevations in arid mountains. It was in the Butler Mountains 3800 years ago and is still there.

Deserts in western Arizona, California, Nevada, Baja California, and northwestern Sonora.

CP: Childs Mt, summit near radio towers, 2845 ft, 18 Aug 1992, *Felger 93-298*. Sierra Pinta, summit, *Cain 15 Nov 2003*.

TA: Tinajas Altas, cliff face, 10 Mar 1980, *Reichenbacher 480*. Butler Mts, *Van Devender 27 Mar 1983*. †Butler Mts, twigs, seeds, 3820 ybp.

Petalonyx – Sandpaper plant

Shrubs or perennial subshrubs, and some may flower in the first year or season; conspicuously scabrous (sandpaper-like) and hispid with short and long hairs. Leaves sessile. Inflorescences racemose or spicate; each flower subtended by an involucre of 3 bracts, the outermost largest and innermost smallest, the bracts enveloping the buds. Petals 5 and white. Stamens 5. The genus is unusual in that the stamens appear to be outside the petals: near the base of the petals the stamens pass through a slit between the petals. Fruits of small achenes, indehiscent and 1-seeded.

Southwestern USA and northwestern Mexico; 5 species.

1. Leaves entire, mostly linear or oblong; petals separate ..... **Petalonyx linearis**
1. Leaves toothed, or if entire then triangular; upper part of claws of petals forming a tube ..... **Petalonyx thurberi**

Petalonyx linearis Greene

Narrow-leaf sandpaper plant. Figure 32.

Figure 32. *Petalonyx linearis*. (A–C) Acuña Valley, 15 Mar 2015. (D) On cinders and lava near Red Cone campground, Pinacate Biosphere Reserve, Sonora, 7 Mar 2009.

Perennials forming rounded bushes 30–50 cm tall, with many erect-ascending brittle and leafy stems, and often flowering during the first season. Leaves gradually drought deciduous, 1.2–3.5 cm long, linear-oblong to linear-lanceolate or linear-oblanceolate, more than twice as long as wide; margins entire. Inflorescences terminal, of densely flowered racemes. Outer floral bract ovate, cordate at the base, the margins entire or sometimes with a few small teeth. Petals, filaments, style,

and stigma translucent white; anthers cream colored. Calyx lobes 1.5 mm long. Petals 3–5 mm long, separate, and narrowed to a slender claw. Stamens about as long as to half again as long as the petals. Achenes ovoid, 2–3 mm long, brown, tightly enclosed in the dried floral tube. Flowering at least in spring and fall.

A calciphile, localized on widely scattered arid, rocky slopes in Organ Pipe and the Tinajas Altas Mountains. It has been in the Tinajas Altas Mountains for more than 9200 years.

Western Arizona, southeastern California to northern Baja California Sur and northwestern Sonora.

OP: Puerto Blanco Drive, 1700 ft, 12 Apr 1978, *Bowers 1259*. 2.5 km NW of Dripping Springs, rocky hills, 9 Mar 1988, *Baker 7589* (ASU).

TA: Tinajas Altas, 1 Dec 1938, *Goodding 5335*. Tinajas Altas, 2000 ft, cliff face, SW-facing slope, 10 Mar 1980, *Reichenbacher 479*. †Tinajas Altas, leaves, 1230 & 9230 ybp.

Petalonyx thurberi A. Gray subsp. **thurberi**
Sandpaper plant; hadsadkam. Figure 33.

Bushy perennials to woody-based shrubs (0.5) 1–1.8 m tall with several to many stems. Larger, lower leaves of new shoots 2–5 cm long, elliptic to lanceolate, coarsely toothed, and soon deciduous; leaves gradually reduced upwards, leaves of upper stems often 0.6–2 cm long, broadly lanceolate to ovate, few-toothed to entire, the uppermost ones triangular. Inflorescences of densely-flowered short racemes. Outer floral bract more or less ovate, coarsely few-toothed. Petals, filaments, style, and stigma white; anthers cream colored. Calyx lobes 2 mm long. Petals 3–6.5 mm long, the claws free basally and connivent (coming together but not organically united) above to form a slender tube. Stamens long exserted. Achenes 1.5–3 mm long. Flowering at least late spring and fall. Stems sometimes bending with weight of flowers, the flowers attracting swarms of hover flies (syrphid flies).

Scattered localities across the lowlands of Cabeza Prieta and Organ Pipe; often in places without other vegetation such as scoured gravelly beds of larger washes.

Western, central, and southern Arizona, southern Nevada, southeastern California to northern Baja California Sur and northwestern Sonora. Another subspecies occurs in California and Nevada.

OP: Bates Well, *Nichol 26 Apr 1939*. Hooker [Hocker] Well, *Simmons 13 Oct 1963*. Camino de Dos Republicas, 2 mi E of Hwy 85, 10 May 1979, *Bowers 1723*. Aguajita Wash, 6 Apr 1988, *Felger_86-288*. Cuerda de Leña (wash), 0.5 mi S of ORPI north boundary, 7 Oct 2006, *Rutman 20061007-18*.

CP: Cameron (Adobe) Wash, *Simmons 19 May 1963* (CAB). Daniels Arroyo at Charlie Bell Rd, 12 Jun 1992, *Felger 92-548*. Growler Wash at E boundary, 12 Jun 1992, *Felger* (observation). Daniel's Arroyo, arroyo gravels, jackrabbit browsed, 31 Mar 1997, *Harlan 486*.

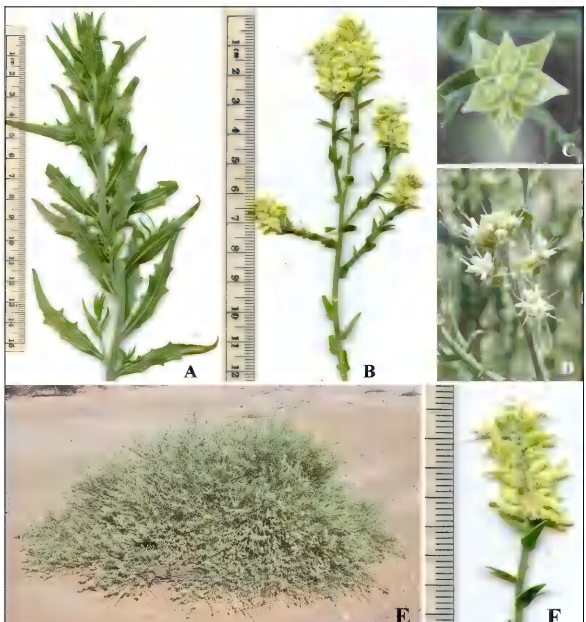

Figure 33. *Petalonyx thurberi* subsp. *thurberi*. (A, C, & F) Ten Mile Wash N of Ajo, 23 May 2010. (B & E) Wash near dunes about 25 miles SW of Sonoyta on Mex Hwy 8, 9 Sep 2014. (D) Growler Wash, N of Bates Well Road, 7 May 2006.

LYTHRACEAE – LOOSESTRIFE FAMILY (includes Punicaceae)
Herbs to trees. Worldwide; 31 genera, 620 species.

****Punica** – Pomegranate
Native to the Middle East and India: 2 species.

****Punica granatum** Linnaeus
Pomegranate; *granada*; galna:yu. Figure 34.

Shrubs to about 3 m tall; planted long ago along irrigation ditches below the pond and perhaps elsewhere at Quitobaquito. Flowers bright red-orange, in March and April and sporadically

through summer; fruits ripe in late summer and early fall. Ripe fruit rinds pale yellowish with a pinkish blush near apex, the fleshy pulp translucent white, refreshing and moderately sweet. Betty Melvin (in Zepeda 1985: 56) recalled, "There were some pomegranates near the water and, yes, we ate pomegranate." Other cutting-grown pomegranates from Quitobaquito, such as ones conserved at the Desert Botanical Garden in Phoenix, have reddish rinds and pale pinkish seeds and pulp.

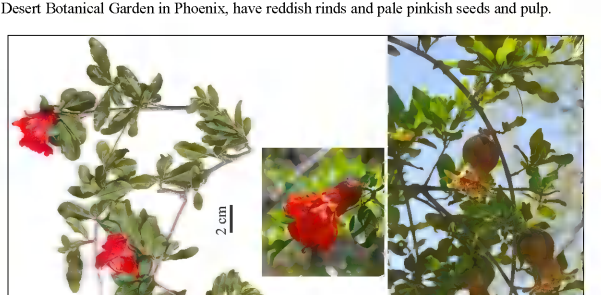

Figure 34. *Punica granatum*. Quitobaquito, 2 May 2008.

Perhaps there were multiple plantings, including those by Arnold N. Dorsey in the 1860s (Hoy 1970: 48; Sue Rutman's extensive genealogy research reveals that Hoy incorrectly called him Andrew Dorsey), and later plantings by O'odham residents (Felger et al. 1992; Zepeda 1985). Pomegranate cultivars are propagated by cuttings and the ones at Quitobaquito found in the late 20th century were apparently one or more clones.

Many of the perhaps few dozen pomegranates had perished by the 1980s. In late 1989 the Park Service began irrigating the plants, and by summer 1990 the surviving plants had recovered remarkably. But subsequent encroachment by *Atamisquea*, *Prosopis velutina*, and *Ziziphus*, along with low rainfall, and the near loss of water in the pond (lowered water table) took a toll on the precarious remnants of the orchard. By 2010 only four pomegranates persisted and were barely surviving in 2011. At that time the Park Service made cuttings and began propagating them in their nursery at the headquarters.

OP: Quitobaquito: *Van Devender 31 Aug 1978* (ORPI); 6 Apr 1988, *Felger 88-309*, Small grove below pond, shrubs to about 3 m tall, 19 Jun 1989, *Felger 89-244*. Desert Botanical Garden, cultivated, from Quitobaquito, *Brown 30 Mar 2005* (DES).

ACKNOWLEDGEMENTS

In addition to the acknowledgments provided in part three of this flora series (Felger et al. 2013b), we especially thank George Ferguson (ARIZ) and Walter Fertig (ASU), as well as Richard (Rick) Alan Johnson (Silver City, New Mexico), Alexander Krings (NCSC), Timothy K. Lowrey and Phil Tonne (NMC), Jim Malusa (Univ. of Arizona), Andrew M. Salywon (DES), Andrew C. Sanders

(UCR), John J. Schenk (Georgia Southern University, GAS), and James (Jim) Thomas Verrier (ARIZ) for significant assistance, information, and reviews. Susan Davis Carnahan provided expert copyediting as well as botanical information. For use of photos we thank Zoya Akulova, Patrick Alexander, Duncan Bell, James W. Cain III, Sue Carnahan, Elizabeth Makings, Keir Morse, Eugene Sturla, and David Sussman.

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 16. EUDICOTS: MALPIGHIACEAE TO MORACEAE

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ABSTRACT

A floristic and natural history account is provided for six eudicot families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona. This portion of the flora includes Malpighiaceae, Malvaceae, Martyniaceae, Molluginaceae, Montiaceae, and Moraceae. Four species are not native, three of which are established as reproducing populations. This is the sixteenth contribution for this flora, published in Phytoneuron. These contributions are also available open access on the website of the University of Arizona Herbarium: http://cals.arizona.edu/ herbarium.

This contribution to our flora in southwestern Arizona includes 6 eudicot families: Malpighiaceae (1 species), Malvaceae (25 species, 14 genera), Martyniaceae (2 species, 1 genus), Molluginaceae (2 species, 2 genera), Montiaceae (4 species, 4 genera), and Moraceae (2 species, 2 genera). The flora area covers 5141 km^2 (1985 mi^2) of contiguous protected areas in the heart of the Sonoran Desert (Figure 1).

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. Explanation of the format for the flora series is provided in part 3 (Felger et al. 2013b). Family designations follow APG III (Angiosperm Phylogeny Group 2009; also see Stevens 2012). Non-native taxa established in the flora area are marked with an asterisk (*) and the one non-native not established in the flora area is marked with double asterisks (**). Fossil taxa are indicated with a dagger symbol (†).

All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2015). All photos and scans are by Sue Rutman unless otherwise stated and botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986). Descriptions and keys pertain to taxa and populations as they occur in the flora area. Local distributions and growth forms are shown in Table 1.

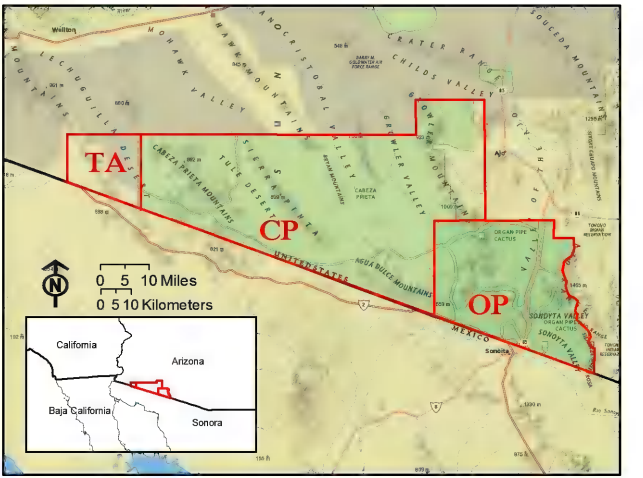

Figure 1. Flora area in southwestern Arizona. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Green shading indicates approximate boundaries of federally designated wilderness.

Table 1. Local distributions and growth forms of Malpighiaceae, Malvaceae, Martyniaceae, Molluginaceae, Montiaceae, and Moraceae. † = Modern taxa also represented by fossil specimen(s); * = non-native species, ** = non-native taxon not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas. SU = summer/warm season ephemerals; WI = cool-season/winter-spring ephemerals; NS = non-seasonal ephemerals; AP = facultative annuals or perennials; PR = perennials. Localities and growth forms in parenthesis are taxa not locally established (not reproducing).

Taxon	Region			Growth Form				
				Ephemerals			Facultative	
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter	Non-Seasonal	Annuals or Perennials	Perennials
MALPIGHIACEAE								
†*Cottsia gracilis*	OP	CP						PR
MALVACEAE								
Abutilon abutiloides	OP							PR
Abutilon incanum	OP	CP						PR
Abutilon malacum	OP	CP						PR
Abutilon palmeri	OP	CP						PR
Anoda pentaschista	OP			SU				
Ayenia filiformis	OP	CP					AP	
†*Ayenia microphylla*	OP							PR
†*Eremalche exilis*	OP	CP			WI			
†*Herissantia crispa*	OP	CP						PR
Hermannia pauciflora	OP							PR
Hibiscus biseptus	OP							PR
Hibiscus coulteri	OP	CP						PR
†*Hibiscus denudatus*	OP	CP	TA					PR
Horsfordia alata	OP	CP	TA					PR
Horsfordia newberryi	OP	CP	TA					PR
†*Horsfordia* sp./spp.	(OP)							(PR)
**Malva parviflora*	OP				WI			
Malvastrum bicuspidatum	OP							PR
Malvella leprosa		CP						PR
Malvella sagittifolia		CP						PR
Rhynchosida physocalyx	OP							PR
Sida abutifolia	OP						AP	
†*Sphaeralcea ambigua*	OP	CP	TA					PR
Sphaeralcea coulteri	OP	CP	TA			NS		
Sphaeralcea emoryi	OP	CP	TA				AP	
Sphaeralcea laxa	OP							PR
†*Sphaeralcea* sp./spp.	(OP)		(TA)					
MARTYNIACEAE								
Proboscidea altheifolia	OP	CP	TA					PR
Proboscidea parviflora	OP			SU				
MOLLUGINACEAE								
**Glinus radiatus*		CP		SU				
**Mollugo cerviana*	OP	CP	TA	SU				
MONTIACEAE								
Calandrinia menziesii	OP				WI			
Calyptridium monandrum	OP				WI			
Claytonia perfoliata	OP				WI			
Phemeranthus aurantiacus	OP							PR

MORACEAE								
***Ficus carica*	(OP)							(PR)
Morus microphylla	OP							PR

MALPIGHIACEAE – Malpighia Family

Herbaceous perennials, lianas, shrubs, and trees. Nearly worldwide, mostly tropical and subtropical regions; 68 genera, 1250 species.

Cottsia

Slightly woody vines, often twining in shrubs. Fruits 2- or 3-winged samaras. Southwestern USA and northwestern Mexico; 3 species. A genus segregated from *Janusia*.

Cottsia gracilis (A. Gray) W.R. Anderson & C. Davis
[*Janusia gracilis* A. Gray]
Slender janusia; *fermina*. Figure 2.

Figure 2. *Cottsia gracilis*. Alamo Canyon trail: (A) 3 Sep 2014; (B) 7 May 2006. (C) Sauceda Mts, 4 Aug 2013. (D) Diablo Canyon, 12 Sep 2013.

Perennial vines climbing 0.5–1.5 (2) m into shrubs and trees, or non-vining in open habitats and as short as 30 cm, often dying back severely in drought; moderately to densely pubescent with double hairs (T-shaped, attached in the middle with 2 opposite-pointing arms–Malpighian hairs). Stems often intertwined, slender, and tough. Leaves opposite, gradually drought deciduous, 1.5–4.5 cm long, short petioled; blades linear to narrowly lanceolate, entire, with 2 (6+) tooth-like red-brown glands 0.1–0.5 mm long near the base; stipules minute or absent. Flowers several or more in axillary clusters or sometimes solitary; pedicels jointed with 2 bractlets; flowers 11.5–13.6 mm wide, 5-

merous and weakly bilateral. Sepals green, 4 of them with paired, fleshy, oval oil glands 0.5–0.9 mm wide (in drought 2 sepals often with only 1 gland), the fifth sepal glandless. Petals and stamens bright yellow, petals 5 in number, 5–6 mm long, subequal, clawed basally, the blade margins fringed or toothed. Fruits of 2 or 3 one-winged nutlets or samaras, each 1–1.4 cm long, the wings papery, green to reddish green. The principal pollinators are anthophorid bees such as *Centris* seeking oil from the sepal glands (*see* Krameriaceae, Felger & Rutman 2015).

Mostly on rocky slopes, hills and mountains, upper bajadas, washes, and canyons scattered across much of the flora area. This small vine has a 14,500-year history in the Ajo Mountains.

Southern Arizona to west Texas, southward to central Mexico, and both states of Baja California.

OP: Walls Well, *Nichol 28 Apr 1939*. 1½ mi N of Bonito Well, 9 Apr 1941, *McDougall 57*. 5.1 mi by road NE of Visitor Center along Ajo Mtn Drive, 5 Nov 1977, *Bowers 909*. Quitobaquito, 29 Mar 1988, *Felger 88-125*. E end of Quitobaquito Hills, N-facing granitic slope, 24 Oct 1990, *Felger 90-478*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation). †Alamo Canyon, fruit, 8,130 to 14,500 ybp (3 samples). †Puerto Blanco Mts, on ridge, fruits, 3440 to 7970 (3 samples).

CP: Childs Mt, 18 Aug 1992, *Felger 92-643C*. Base of Scarface Mt, 1650 ft, *Autenreith 20 Mar 1992* (ASC). Observations, *Felger*: 1 mi W of Refuge boundary on Charlie Bell Rd, 18 Aug 1992; N side Sheep Peak, 31 Jan 1992; N side Tule Mountains, 2 Feb 1992; Canyon at Agua Dulce Tank, Cabeza Prieta Tanks, Heart Tank, 13–15 Jun 1992.

MALVACEAE – Mallow Family (includes Sterculiaceae)

Ephemeral or perennial herbs, shrubs with soft wood (elsewhere also trees, some very large, such as *Ceiba*); mostly with stellate hairs, some also with forked or simple hairs. Leaves alternate, simple (those in the flora area) but sometimes deeply cut, stipules usually well developed. Flowers usually radial, often subtended by an epicalyx (involucel)—bracts immediately subtending the calyx, or the epicalyx absent. Calyx 5-lobed or parted; petals 5, separate except where fused basally to the stamen tube. Stamens mostly many or 5 or more, the filaments united at least basally, or more often united into a column surrounding the ovary and style, the upper portions of filaments free from the column. Fruits (those in the flora area) capsular (opening through longitudinal splits) or schizocarps (separating into single-carpel segments or mericarps).

Worldwide, mostly tropical and temperate; 240 genera, 4350 species. Mallows in the local flora include 14 genera with 25 species (Table 1). Nearly all (23 species, 92%) occur in Organ Pipe and 15 (60%) in Cabeza Prieta, and only 6 species (2.4%) occur in the hyperarid Tinajas Altas area. The majority (18 species, 72%) of the mallows in the flora area are perennials, and only 7 species are annuals.

1. Flowers minute (5–6 mm wide), the perianth maroon, with 5 fertile stamens and 5 staminodes; fruits 5 mm wide, globose, and studded with blunt spines…….. **Ayenia**
1. Flowers mostly at least 10 mm wide with petals of various colors but not maroon; stamens 5 (*Hermannia*) or numerous; fruits mostly more than 5 mm long or wide, globose or not, not studded with blunt spines.

2. Herbaceous perennials; flowers yellow, the stamens 5, the filaments united basally; capsules with 5 thin, bristly wings…….. **Hermannia**
2. Annuals/ephemerals, perennials, or shrubs; flowers of various colors including yellow, the stamens numerous, the filaments united in a column; fruits not with bristly wings as above.

3. Perennials; fruit a loculicidal capsule of 5 persistent segments each with a standing rib (septum), opening wide at maturity..... **Hibiscus**
3. Ephemerals and perennials; fruit a schizocarp, the segments (mericarps) indurate to papery and inflated, dehiscent or indehiscent, persisting or dispersing.

4. Lower leaves petioled, upper leaves of flowering branches sessile; flowering and fruiting pedicels thread-like (filiform), bent at a conspicuous joint; fruits inflated like miniature paper lanterns..... **Herissantia**
4. Lower and upper leaves petioled; pedicels usually not thread-like and mostly not bent at a joint; fruits not inflated.

5. Lower and upper portions of each mericarp markedly dissimilar, the lower chamber indehiscent, the upper part dehiscent with flared membranous wings.

6. Tall, slender shrubs; epicalyx absent..... **Horsfordia**
6. Small to tall annuals or bushy perennials or small shrubs; epicalyx present, of 3 bracts. ..... **Sphaeralcea**

5. Mericarps with a single chamber (not differentiated into upper and lower chambers).

7. Herbaceous root perennials with prominent rhizomes; leaf blades conspicuously asymmetric at base..... **Malvella**
7. Annuals or perennials, without rhizomes; leaf blades symmetric.

8. Perennials from a thick, carrot-like root; epicalyx absent; calyx enlarging and inflated in fruit..... **Rhynchosida**
8. Root not markedly thick; epicalyx present or absent; calyx not conspicuously enlarging and not inflated.

9. Epicalyx none; mericarps 5–10, 1- or 3-seeded.

10. Robust herbaceous perennials or shrubs; fruits 6–15 mm wide; mericarps 8–10, 3-seeded..... **Abutilon**
10. Ephemerals or small, delicate perennial herbs; fruits 4–5 mm wide, mericarps 5, 1-seeded.

11. Summer-fall ephemerals; lower (larger) leaves mostly more than 5 cm long, the blades relatively thick (coriaceous), ovate and often 3 lobed, the margins coarsely toothed or not; petals 10 mm long, and entire. ..... **Anoda**
11. Small annuals/ephemerals or weakly perennial herbs; larger leaves often 1.5–4 (6) cm long, the blades ovate to oblong, thin, usually cordate at base, the margins crenate-toothed; petals 5–6 mm long, shallowly notched at tip..... **Sida**

9. Epicalyx present; mericarps (8) 10–15, 1-seeded.

12. Small shrubs with slender but woody stems; epicalyx with conspicuous lanceolate bracts; corollas orange; mericarps 9–11, horseshoe-shaped with 2 dorsal cusps..... **Malvastrum**
12. Winter-spring ephemerals (annuals); epicalyx with inconspicuous filiform bracts; corollas white or pale pink; mericarps (8) 10–15, without dorsal cusps.

13. Leaf blades ovate; petals entire, not notched; fruits 4–4.5 mm wide; mericarps 12–15……. **Eremalche**
13. Leaf blades orbicular to kidney-shaped; petals deeply notched at the tip; fruits 7–8 mm wide; mericarps about 10 (11)……..…….. **Malva**

Abutilon – Indian mallow; *Malva*

Herbaceous perennials or shrubs (those in the flora area, elsewhere also trees), the herbage usually densely pubescent with stellate hairs. Pedicels jointed (usually best seen on fruiting pedicels, the fruits usually break off at the joint). Epicalyx none. Corollas often yellow or orange. Fruit a schizocarp; mericarps 5–10, often with 3 seeds each (the mericarps are laterally fused to a greater or lesser extent and are not released). Flowering during warm months with sufficient soil moisture.

Nearly worldwide, mostly tropics and subtropics; 160 species.

1. Capsule segments (mericarps) 5, the tips blunt and rounded; calyx lobes not overlapping, the fruiting calyx shorter than the mericarps.

2. Leaf tips mostly acute-acuminate (pointed); fruiting calyx 2.8–4 mm long, ¼ as long as mericarps; petals pale orange with a maroon spot at the base…….. **Abutilon incanum**
2. Leaf tips obtuse (blunt); fruiting calyx 4–6 mm long, ½ to ¾ as long as the mericarps; petals uniformly yellow-orange…….. **Abutilon malacum**

1. Mericarps 7 or more, the tips slender and pointed; calyx lobes overlapping basally, the fruiting calyx about as long as the mericarps.

3. Leaf blades not especially velvety; stems and mericarps with hairs less than 0.5 mm long. ……... **Abutilon abutiloides**
3. Leaf blades soft and velvety; stems and mericarps with hairs 0.8–2.5 mm long. …… **Abutilon palmeri**

Abutilon abutiloides (Jacquin) Garke ex Hochreutiner
Pintapán. Figure 3.

Shrubs to less than 1 m tall, the branches often spreading. Leaf blades broadly ovate, 2–10 cm long, the margins shallowly toothed. Petals, stamens, and styles yellow to pale orange, petals 1 cm long; stigmas red. Fruits 10–15 mm wide; fruiting calyx about as long as the mericarps, the mericarps 8–10, 3-seeded; carpel walls with small stellate hairs and longer simple hairs (to 1 mm long) on the upper (dorsal) margin. Seeds 3 per mericarp, 3 mm long, with minute hairs arranged in a reticulate pattern, recurved when dry, standing up straight when damp or wet. Flowering response non-seasonal.

Ajo Mountains, especially in canyons, and locally in the Puerto Blanco Mountains. Southern Arizona and Texas to Oaxaca, and the Caribbean.

Abutilon californicum Bentham is a Gulf of California segregate of the more widespread, inland, southern, and tropical *A. abutiloides*. *Abutilon californicum* extends northward to the Pinacate region in Sonora near the flora area but is not known to range into Arizona. The distinctions between these taxa are subtle differences in pubescence (see Fryxell 1988); they are geographically narrowly segregated and it remains to be seen if they intergrade at the zones of contact in Sonora.

OP: Alamo Canyon, 3 Dec 1977, *Bowers 990*. Arch Canyon, 900 m, *Felger 90-533*. Large wash draining NE slopes of Pinkley Peak, 31 Oct 2003, *Rutman 20031031-40* (ORPI).

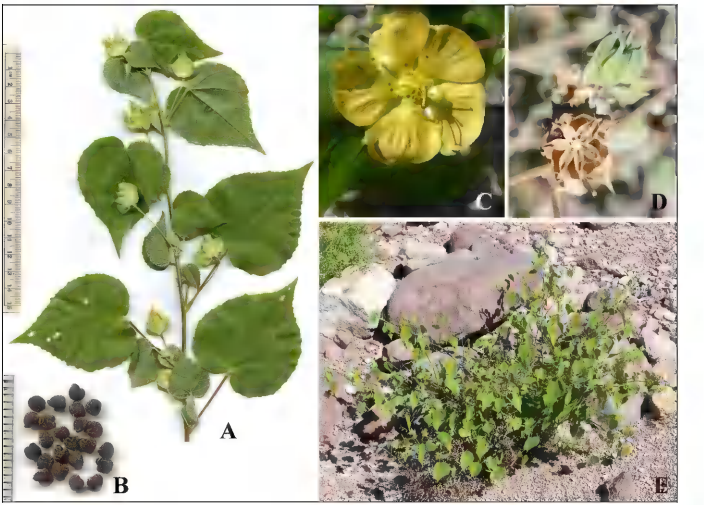

Figure 3. *Abutilon abutiloides*. Alamo Well: (A) 3 Sep 2014; (D) 26 Feb 2014; (E) 15 Sep 2013. (B) Boulder Canyon, 30 Sep 2014. (C) Below Molino Basin, Santa Catalina Mts, 13 Aug 2010, photo by Ries Lindley.

Abutilon incanum (Link) Sweet
[*A. pringlei* Hochreutiner]
Pelotazo. Figure 4.

Shrubs often 1–1.6 m tall with slender, upright stems; densely and velvety pubescent with minute stellate hairs. Petioles prominent; leaf blades ovate, often 3–10 cm long, cordate at the base, acute to acuminate at the tip, greener above, gray-green below, the margins toothed. Flowers solitary in leaf axils and in large, open, terminal inflorescences. Pedicels often jointed 2.5–3 mm below the calyx, the pedicel usually thickened above joint even in bud. Corollas pale orange with large maroon spots in the center; petals 4–6 mm long, reflexed with age; filaments red below, yellow above; stigmas red. Fruits 6.5–8 mm × 5–7 mm; mericarps 5, blunt tipped, nearly always 3-seeded; fruiting calyx 2.8–4 mm long.

Canyons and rocky slopes, often north facing, in ranges along the east side of Cabeza Prieta and widespread in Organ Pipe.

Arizona, New Mexico, and Colorado and northwestern Mexico in both states of Baja California, Sinaloa, and Sonora, and disjunct in Hawaii.

OP: Alamo Canyon, 17 Dec 1939, *Harbison 26264*. Dripping Springs, 16 Apr 1952, *Parker* 7906. Estes Canyon, *Hesselberg 16 Oct 1966*. Foothills of Santa Rosa Mts, W of Diaz Peak, 2 Apr 2003, *Rutman 2003-440* (ORPI). Senita Basin, *Warren 10 Apr 1975*.
CP: Agua Dulce Mts, 14 Sep 1992, *Felger 92-728*.

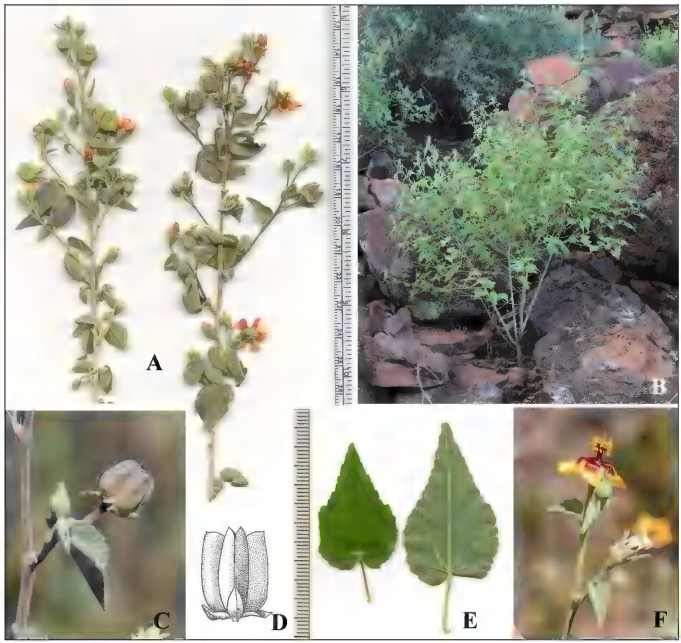

Figure 4. *Abutilon incanum*. Alamo Canyon: (A) 24 Mar 2008; (C) 26 Mar 2005; (F) 26 Feb 2014. (B) Bull Pasture Trail, 8 Sep 2014. (D) By Lucretia Breazeale Hamilton. (E) Diablo Canyon near Ajo Mountain Drive, 30 Sep 2014.

Abutilon malacum S. Watson
Yellow Indian-mallow. Figure 5.

Shrubs 0.5–1 m tall; densely, velvety, and minutely stellate pubescent. Petioles prominent; leaf blades often 1.5–6 cm long, broadly ovate to orbicular, cordate at base, obtuse at tip, dull green above, somewhat yellow-green below with prominent raised veins, the margins toothed. Flowers solitary in leaf axils or in few-flowered terminal inflorescences. Pedicels 12–30 mm long, the joint often 2–9 mm below the calyx base, the joint occasionally obscure, the pedicel usually thickened above the joint. Corollas and stamens uniformly yellow-orange, the corollas spreading, 1.5 cm wide. Fruiting calyx 4–5 mm long. Fruits 6–8 mm wide and long; mericarps 5, the tips blunt, 3-seeded.

Canyons and rocky slopes in Organ Pipe and the eastern part of Cabeza Prieta.

Southern Arizona to Texas, and southward to northern Sonora and San Luis Potosí.

OP: 40 mi Drive, in *Olneya* and *Acacia* thicket, 12 Jul 1962, *Ranzoni 192* (ORPI). Pinkley Peak, *Wirt 11 Nov 1988*. Puerto Blanco Mts, *Wirt 17 Sep 1990*.

CP: Cabeza Prieta Tanks, 6 Apr 1979, *Lehto L23521*. Scarface Mt, 1650 ft, *Autenreith 20 Mar 1992* (ASC). Canyon of Agua Dulce Spring, 26 Feb 1993, *Felger 93-87*. N bajada of Little Ajo Mts at Charlie Bell Road, 5 Sep 2014, *Rutman 20140905-7*.

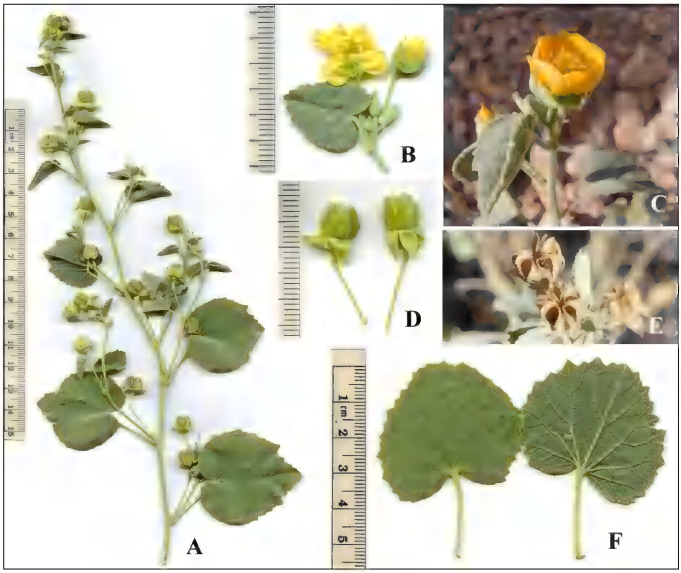

Figure 5. *Abutilon malacum*. (A & F) Sierra Los Tanques, Sonora, 7 Sep 2014. (B & D) Foothills of Little Ajo Mts at Charlie Bell Road, 5 Sep 2014. (C) Waterman Mts, Ironwood Forest National Monument, 23 Feb 2014, photo by Sue Carnahan. (E) Wash crossing Ajo Mountain Drive, Diablo Mts, 17 May 2015.

Abutilon palmeri A. Gray
[*A. aurantiacum* S. Watson, not *A. aurantiacum* Linden ex Turczaninow. *A. macdougalii* Rose & Standley]
Palmer's Indian-mallow. Figure 6.

Sparsely branched, open and scarcely woody subshrubs to 1.5+ m tall; densely stellate pubescent and also with longer simple hairs. Petioles of larger leaves (2.5) 4–13 cm long; leaf blades conspicuously soft velvety, broadly ovate to nearly orbicular, light green above and lighter colored below, the larger ones 4.5–15 cm long, minutely to coarsely toothed, deeply cordate at base, acuminate-acute to obtuse at tip. Flowers showy, in large, slender-stemmed, open and sparsely branched terminal panicles rising well above the foliage, and also solitary in leaf axils. Pedicel length highly variable, the joint often inconspicuous at flowering time, the pedicel often thickened above joint and usually conspicuous at fruiting time. Petals pale orange, 2–2.5 cm long. Fruiting calyx about as long as the mericarps; fruits 13–15 mm wide, the mericarps about 10, 3-seeded.

Canyons in the Cabeza Prieta Mountains and mountains in Organ Pipe.

Southwestern Arizona to Sinaloa, and southeastern California to Baja California Sur; disjunct in Tamaulipas.

OP: 10 mi S of Bates Well, 5 Mar 1940, *Benson 9923*. Alamo Canyon, 14 Mar 1941, *Benson 10686*. Dripping Springs, 16 Apr 1952, *Parker 7948*. Canyon Diablo, 13 Feb 1978, *Bowers 1056*.
CP: Cabeza Prieta Tanks, 6 Apr 1979, *Lehto L23521* (ASU).

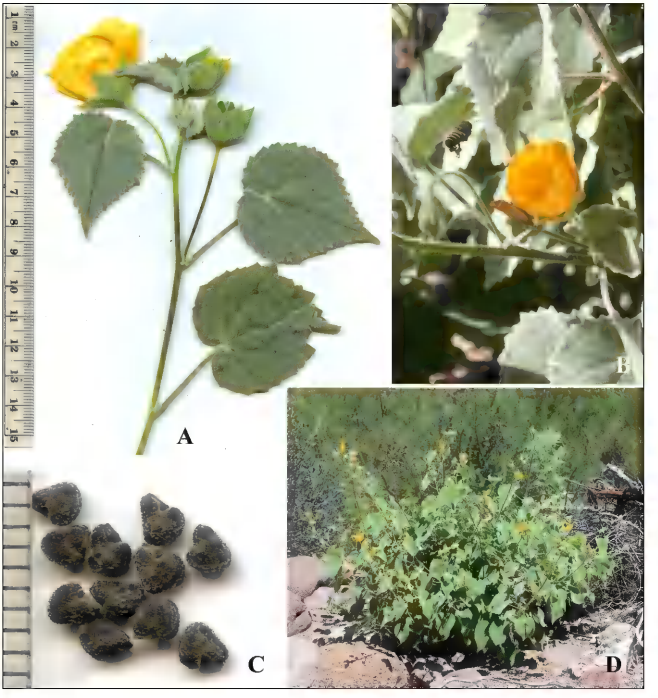

Figure 6. *Abutilon palmeri*. Ajo: (A) 6 Mar 2015; (B) 4 Mar 2006; (C) 20 Sep 2014. (D) Estes Wash, 0.5 mile S of Estes Canyon trailhead, 12 Sep 2013.

†Abutilon sp.
OP: †Puerto Blanco Mts, on ridge, capsule, 3440 ybp.
TA: †Tinajas Altas, mericarp fragments, 5860 to 11,040 ybp (3 samples).

Anoda

Ephemerals or perennial subshrubs. Americas and Australia, mostly in Mexico, 23 species.

Anoda pentaschista A. Gray
Field anoda. Figure 7.

Summer-fall ephemerals; erect-growing, slender and generally sparsely-branched; sometimes reaching 1 m tall. Younger stems sparsely stellate-tomentose or glabrate. Leaf blades relatively thick, highly variable, the lower leaves often broadly lanceolate, toothed, and sometimes with 2 large, basal lobes, the larger leaves often reaching 10+ cm long and soon deciduous, the upper leaves substantially smaller, narrower, and often linear. Floral bracts (epicalyx) absent. Flowers small, calyx 3–5 mm long. Petals 1 cm long, yellow-orange. Fruits schizocarps, globose-depressed (oblate, flattened at each end), 4–5+ mm wide; mericarps usually 5, the lateral walls disintegrating at maturity.

Figure 7. *Anoda pentaschista*. Bull Pasture: (A & C) 21 Sep 2008; (B) 24 Sep 2006.

Known in the flora area only from Bull Pasture and Arch Canyon in the Ajo Mountains. This is the westernmost record for this species.

Eastward across southern Arizona to Texas and through much of Mexico, often in disturbed habitats. Weedy and not native in southeastern California.

OP: Bull Pasture: 3020 ft, *Wirt 12 Aug 1990*; Vicinity of the weather station, *Rutman 24 Sep 2006*. Trail to the arch in Arch Canyon, 12 Sep 2014, *Rutman*, photo.

Ayenia

Shrubs or herbs with stellate hairs. Leaves simple, the margins toothed or serrated. Flowers pedicelled, axillary, minute, reddish and intricately sculptured. Calyx 5-lobed, somewhat petal-like. Petals 5, the tips united with the stamen tube; stamens united in a short column bearing 5 fertile stamens and 5 sterile stamens (staminodes). Fruits of small, rounded capsules, studded with blunt spines or tubercles, 5-celled, at maturity separating into five 1-seeded carpels. Americas; 80 species.

1. Ephemerals or dwarf subshrubs, often few branched or with many short, non-woody stems and the plants less than 40 cm tall; leaves often longer than wide; capsules with a stipe (the fruit "stalk" above an obvious joint; the part below the joint is the actual pedicel) 1.4–2 mm long..... **Ayenia filiformis**
1. Shrubs 0.5–0.8+ m tall, with many rigid, spreading and slender but woody branches; leaves often about as wide and long; capsules with a stipe 0.2–0.6 mm long..... **Ayenia microphylla**

Ayenia filiformis S. Watson

[*A. pusilla* of various authors, not *A. pusilla* Linnaeus. *A. compacta* Rose]. Figure 8.

Ephemerals to dwarf perennials with slender mostly erect stems, often few-branched, sometimes to 50 cm tall but usually much shorter, especially when grazed and then often with rigid, stubby, and spreading branches. Plants with simple and stellate hairs, sometimes sparsely pubescent especially with ample soil moisture and when shaded. Leaves drought deciduous, petioled, 1–3.8 cm long, the dry-season leaves reduced; leaf blades linear to narrowly lanceolate, or sometimes elliptic to ovate, the margins toothed. Flowers axillary, minute, the calyx green and maroon, the petals maroon; flowering response non–seasonal except during colder weather. Capsules rounded, 4.6–5 mm wide, with blunt spines (tubercles) and stellate hairs. Seeds dark red-brown to nearly black, 2.5–3 mm long, resembling a beetle pupa. Growing with warmer weather, especially with summer-fall rains.

Unevenly scattered in mountains and hills, often in rock crevices. Plants often severely browsed, perhaps by desert bighorn and also by chuckwallas. Compact, dwarfed plants in drier habitats, such as lower elevations in Organ Pipe and probably in the central or western part of Cabeza Prieta, may be identified as *A. compacta*, distinguished by shorter tubercles (projections) on the capsules, but it seems scarcely distinct from *A. filiformis* (Felger 2000).

Western and southern Arizona, southeastern California, New Mexico, western Texas, both states of Baja California, and Sonora to Sinaloa, Coahuila, and Zacatecas.

OP: Dripping Springs, 29 Jan 1978, *Bowers 1020*. Bull Pasture Trail, 2500 ft, 9 May 1979, *Bowers 1703*. Diablo Canyon, 12 May 1988, *Baker 7607* (ORPI). Senita Basin, *Rutman 10 Oct 1995* (ORPI). Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-25*.

CP: Tule Tank, 14 Apr 1992, *Harlan & Steinmann 292* (CAB). Vicinity of Agua Dulce Pass, 14 Sep 1992, *Felger 92-736*.

Figure 8. *Ayenia filiformis*. Arch Canyon Trail: (A) 21 Sep 2008; (F) 16 Sep 2006. (B) Alamo Canyon, 9 Sep 2013. (C) Rancho la Proveedora, Caborca, Sonora, 1 Mar 2013. (D) Cerro Trincheras, Trincheras, Sonora, 3 Mar 2015. (E) Bull Pasture Trail, 19 Sep 2014. Photos C & D by Sue Carnahan.

Ayenia microphylla A. Gray
Shrub ayenia. Figure 9.

Subshrubs, usually less than 1 m tall, with many slender, spreading, and rigid stems. Plants with stellate hairs, those on the stems have appressed arms. Leaves short-petioled, the blades mostly 3–10 mm long, broadly ovate to rounded, the margins toothed. Flowers reddish and green, minute, flowering during warmer months. Capsules about 5 mm wide, with blunt spines (tubercles) and stellate hairs. Seeds 3 mm long.

Ajo, Diablo, and Puerto Blanco mountains; usually rather localized. It has been in the Ajo Mountains for at least 12 centuries.

Southern and central Arizona to western Texas, Sonora, and the Chihuahuan Desert Region in northern Mexico.

OP: Arch Canyon, 10 Apr 1949, *Fouts 441*. Canyon Diablo, 15 Apr 1951, *Supernaugh 441* (ORPI). Main campground, 1 mi SW of Visitor Center, 13 Sep 1978, *Bowers 1523* (ORPI). Foothills ENE of Pinkley Peak, 31 Oct 2003, *Rutman 20031031-32* (ORPI). †Alamo Canyon, leaves, seeds, 1150 ybp.

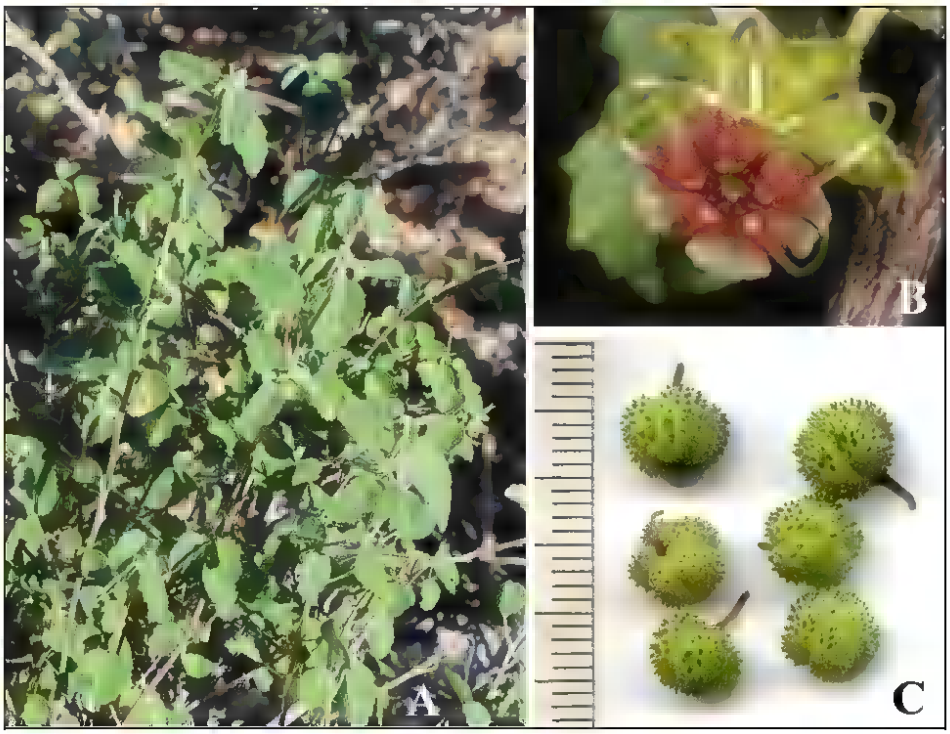

Figure 9. *Ayenia microphylla*. (A) Base of Pinkley Peak, 8 Aug 2013. (B) Foothills of Rincon Mts, Vail, Pima Co., 20 Jul 2013, photo by Jillian Cowles (SEINet). (C) Desert View Trail, near Twin Peaks Campground, 12 Mar 2015.

Eremalche

Annuals. Southwestern USA and northwestern Mexico; 3 species.

Eremalche exilis (A. Gray) Greene
White mallow. Figure 10.

Spring ephemerals with stellate hairs less than 0.5 mm long and some simple hairs. Stems to 60 cm long, several to many, mostly branching from near the base, spreading to decumbent, slender, and often few-branched. Leaf blades palmately 3- or 5-lobed, the lobes divided to toothed or entire. Flowers axillary and solitary. Epicalyx of 3 bractlets, persistent, separate, linear, and about ⅔ as long as the calyx. Pedicels often longer than the leaves. Calyx 4–6 mm long. Petals 3–5 mm long, white to pale lavender and without basal spots. Fruits globose-depressed, 4–4.5 mm wide; mericarps 12–15, blackish, 1.5–1.8 mm wide, margins sculptured, indehiscent or eventually the thin lateral walls rupturing, 1-seeded, the seed filling the central cavity of the mericarp.

Sandy soil plains and low, stabilized dunes near the international border in Cabeza Prieta and more widespread in nearby northwestern Sonora. Also in sandy washes in the Ajo Mountains and the northern part of Organ Pipe in 1939 and 1941 and not recorded there since,

Western and southern Arizona, southern California, Utah, Nevada, Baja California, and northwestern Sonora.

The plants were cooked as greens with wheat flour by the Gila River Pimas as emergency food (Rea 1997; see *Malva parvifolia*).

OP: Alamo Canyon, *Nichol 26 Mar 1939*. Wash near Sonoyta road, 10 Apr 1941, *McDougall 70*.
CP: Dunes, E edge of Pinacate Plateau, 30 Mar 1938, *Wiggins 6557* (RSA). Pinta Sands, 10 April 1978, *Reeves 6787* (ASU).

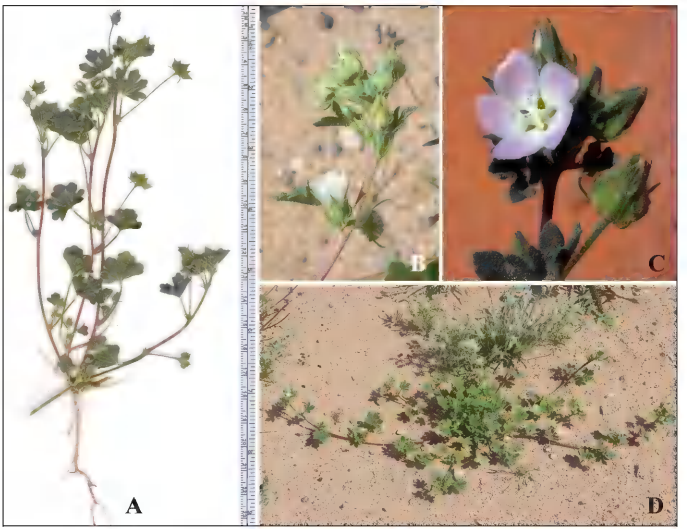

Figure 10. *Eremalche exilis*. (A) Estes Canyon, 3 Apr 2010. (B & D) Lago Seco, Barry M. Goldwater Range, Maricopa Co., 18 Mar 2014. (C) Pinta Sands E of lava flow, 9 Apr 2010, photo by Henry (Hank) Jorgenson (SEINet).

Eremalche rotundifolia (A. Gray) Greene

This winter-spring ephemeral is common in nearby northwestern Sonora and west and north of the flora area in Arizona. Often found on sandy soils, it has relatively large flowers, and the petals are pink with dark maroon basal spots.

Herissantia

Annual and perennial herbs, and shrubs. Warm regions of the Americas; 5 species.

Herissantia crispa (Linnaeus) Brizicky
[*Abutilon crispum* (Linnaeus) Medicus. *Bogenhardia crispa* (Linnaeus) Kearney]
Bladder mallow. Figure 11.

Perennial herbs to sub-shrubs, also flowering in the first year or season. Stems slender and weak, upright to trailing, arching or semi-vining and often growing through shrubs, sometimes to 1 m long from a scarcely woody base. Hairs soft and stellate, sometimes also with long straight hairs. Leaves long petioled on vegetative stems, the blades broadly ovate, relatively thin, 3–7 cm long, the

base cordate, the tip acute to acuminate-acute, the margins crenate-toothed; stipules (2) 3–7 (10) mm long, string-like, green, and relatively persistent; leaves sessile and usually much smaller on flowering stems. Flowers solitary in leaf axils, the flowering and fruiting pedicels slender and conspicuously jointed, with a prominent elbow-like bend at the joint (the pedicels bend conspicuously downward, unlike in *Abutilon*, which remain erect). Epicalyx absent. Flowers 1.5 cm wide, the petals pale yellow-orange. Fruits globose, inflated, 1.3–1.5 cm wide, papery, resembling a miniature paper lantern, mericarps separating at maturity. Flowering and fruiting mostly during warm, moist weather.

Figure 11. *Herissantia crispa*. (A) Estes Canyon, 11 Sep 2008. (B & C) Cerro Proveedora, Rancho Puerto Blanco, Caborca, Sonora, 1 Mar 2015, photos by Sue Carnahan. (D) Hat Mountain, Sauceda Mts, 22 Mar 2014. (E) Alamo Canyon, 9 Sep 2013.

Widespread across the flora area but seldom on open desert flats; canyons, washes, arroyos, and rocky hills and mountains, often beneath spiny shrubs such as ironwoods (*Olneya*) and among rocks. A specimen 3500 years old was found in the Puerto Blanco Mountains.

Arizona to Texas and Florida, to Argentina and Bolivia, and the West Indies, adventive in the Old World and often weedy.

OP: Alamo Canyon, *Harbison 13 Dec 1939.* 10 mi S of Bates Well, 5 May 1940, *Benson 9905.* Dripping Springs, 16 Apr 1952, *Parker 7949.* Puerto Blanco Drive, 5.2 mi W of Visitor Center, 16 Oct 1977, *Bowers 889.* †Puerto Blanco Mts, on ridge, capsule, 3440 ybp.

CP: Agua Dulce Spring, 13 Apr 1964, *Niles 343.* Heart Tank (Simmons 1966). Christmas Pass, 13 Apr 1992, *Harlan 255.* Pinacate Lava, 15 Sep 1992, *Felger 92-770.*

Hermannia

Mostly in Africa, Arabia, and few in Australia and southwestern USA to Central America; 180 species.

Hermannia pauciflora S. Watson

Dwarf burstwort. Figure 12.

Small, straggly perennials with stellate hairs, the herbage drought deciduous. Stems herbaceous, often reddish, to 30 cm long, erect to trailing, dying back in drought to a knotty or semi-woody base. Herbage, calyx, and petal bases often reddish. Leaves petioled; blades triangular-lanceolate to ovate, 0.5–1+ cm long, the margins coarsely toothed. Flowers solitary from leaf axils; pedicelled. Petals bright yellow, 6–8 mm long. Stamens 5, united basally. Fruits of reddish brown, papery capsules, 1–1.5 cm long, ovoid, and bristly along 5 thin, toothed wings; seed many and kidney-shaped. Flowering non-seasonally with warm weather and sufficient soil moisture. (Description based on southern Arizona and Sonora specimens.)

Figure 12. *Hermannia pauciflora.* King Canyon, Tucson Mts, 21 Feb 2009, photos by Patrick Alexander.

Discovered in the Ajo Mountains by Beth Fallon in 2011, this record is the westernmost outpost for the species. The nearest known populations are in the Tucson and Waterman mountains. This small, rather inconspicuous plant is easily overlooked, especially when dormant.

Southern Arizona and Sonora southward to the Guaymas Region, and northern Mexico eastward to Tamaulipas. As of 2013, *H. pauciflora* was considered globally threatened by NatureServe, but in reality it is not rare or threatened.

OP: Foothills of Ajo Mts, near Arch Canyon with *Simmondsia chinensis*, rocky and bouldery, 2750 ft, west aspect, UTM 337421, 354659630, *Fallon 30 Mar 2011*.

Hibiscus

Perennials, suffrutescent or subshrubs (those in the flora area) with stellate hairs. Stipules awl-shaped to leaf-like, falling early. Epicalyx relatively large and conspicuous or highly reduced. Fruit a capsule of 5 persistent carpels, laterally fused, splitting dorsally; capsules at maturity spreading open, star-shaped. Seeds densely covered with long, silky hairs (those in the flora area). Worldwide; 350 species (although *Hibiscus* is paraphyletic).

1. Leaves broadly ovate to obovate and toothed, not lobed or parted; epicalyx inconspicuous, less than 0.5 cm long, shorter than the carpels; corollas white to pink, often with a maroon center. …… **Hibiscus denudatus**
1. Adult leaves deeply 3-lobed or 3-parted; epicalyx conspicuous, the bracts more than 1 cm long, longer than the carpels; corollas yellow with a maroon center.

2. Stems with simple or 2- or 3-rayed hairs, these not appressed, and also with two vertical lines of small, recurved hairs extending down from the leaf bases…… **Hibiscus biseptus**
2. Stems with evenly distributed 4-armed hairs, the arms closely appressed to the stem. …… **Hibiscus coulteri**

Hibiscus biseptus S. Watson
Arizona rose-mallow. Figure 13.

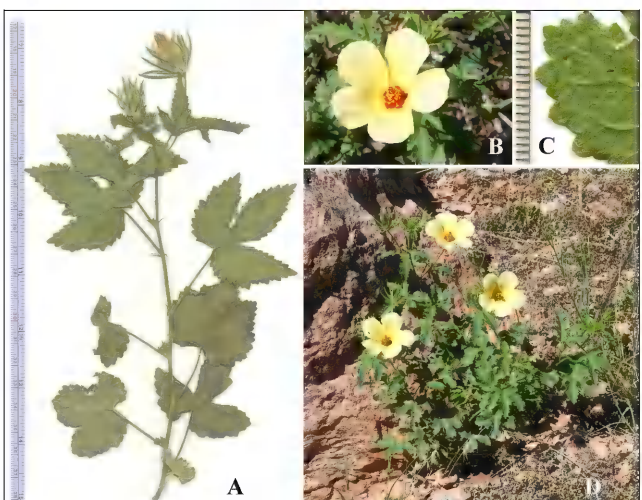

Figure 13. *Hibiscus biseptus*. Arch Canyon: (A) 13 Sep 2013; (B & D) 16 Sep 2006; (C) 26 Aug 2014.

Perennial herbs often forming few-branched, leafy plants. Stems with simple or 2- or 3-rayed hairs, these not adpressed, and two vertical lines of small, recurved hairs extending down from the leaf bases (stipules). Leaves deeply 3-parted, with slender segments more than twice as long as wide, with raggedly toothed margins; juvenile and new-growth leaves not as deeply parted. Corollas yellow, large and showy, with a red center, similar to those of *H. coulteri*; flowering during the warmer months with sufficient moisture.

Known from the Ajo Mountains, from the trails to the Arch and Bull Pasture, and Alamo Canyon.

Arizona and northwestern Mexico to Jalisco, and both Baja California states.

OP: Alamo Canyon, N fork, 700 m, 16 Oct 1987, *Baker 7557* (ASU; mixed collection with *H. coulteri*). Below the arch, Arch Canyon, 2880 ft, 12 Sep 2013, *Rutman 20130912-22*.

Hibiscus coulteri Harvey ex A. Gray
Desert rose-mallow. Figure 14.

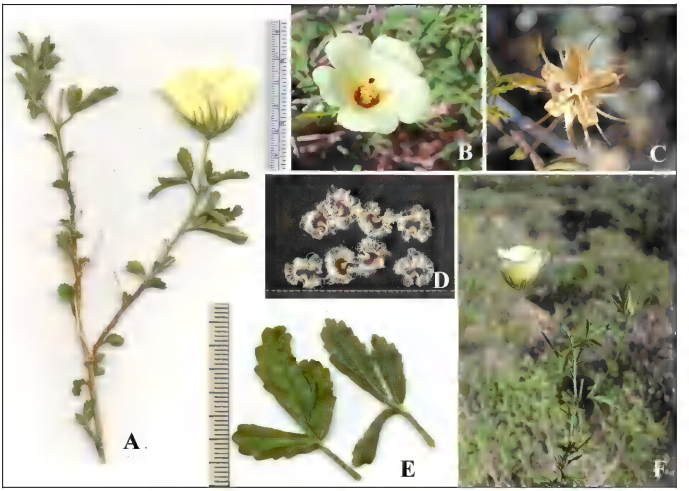

Figure 14. *Hibiscus coulteri*. Alamo Canyon: (A) 10 Sep 2008; (B) 7 Sep 2013. (C) Near Victoria Mine, 23 Dec 2013. (D) Seeds, Boulder Canyon, 30 Sep 2014. (E & F) Arch Canyon, 26 Aug 2014.

Subshrubs or herbaceous perennials, often forming few-branched, spindly plants to nearly 0.5 m tall. Stems slender and firm; densely pubescent with whitish, stellate hairs with 4 conspicuously adpressed arms, the hairs more or less evenly distributed around the stem. Leaves deeply 3-parted,

the segments more than twice as long as wide, with raggedly toothed margins; juvenile and new-growth leaves not as deeply parted. Floral bracts slender, rigid, and longer than the carpels. Flowers large and showy, often 5 cm wide; calyx 1.6–2 cm long, deeply divided into lanceolate lobes; corollas yellow with a maroon center, the petals mostly 2.5–3+ cm long; flowers opening after sunrise and closing at night; warmer months with sufficient moisture.

Rocky slopes and thin soils on the east side of Cabeza Prieta and across Organ Pipe. Usually growing within other plants, either because they escape grazing there or for support for the spindly stems.

Southern Arizona to southern Texas, and Sonora to Zacatecas, and Baja California.

OP: Alamo Canyon, 13 Dec 1939, *Harbison 26248*. Headquarters, *McDougall 10 Apr 1941*. Dripping Springs, 16 Apr 1952, *Parker 7947*. Bull Pasture Trail, 9 May 1979, *Bowers 1706*.
CP: Childs Mt, 9 Apr 1993, *Felger 93-286*.

Hibiscus denudatus Bentham
Rock hibiscus. Figure 15.

Multiple-stemmed perennial herbs or subshrubs, branched from the base, 0.3–1 m tall, dying back to a thickened woody base in extreme drought. Herbage pale yellow-green, densely pubescent with stellate hairs. Leaves petioled, (2) 2.5–4.5 cm long; leaf blades broadly ovate to oblong-ovate, rounded to obtuse at tip, the margins toothed; rainy-season leaves greener, thinner, and larger than dry-season leaves; leaves gradually drought deciduous. Floral bractlets usually appressed and inconspicuous, the longer ones 1–3 mm, the tips often breaking off early, and sometimes difficult to distinguish in color and texture from base of calyx. Calyx 10–16 mm long, deeply divided into lanceolate lobes. Corollas white to pinkish or pale lavender with maroon spots in the center, the petals often 2–2.7 cm long. Seeds covered with silky hairs 3–4 mm long. Flowering at various seasons with sufficient moisture, especially warmer months in spring.

Widespread and common across the flora area, mostly hills and mountains, arroyos and slopes. It has grown in Organ Pipe for at least 7600 years and in the Tinajas Altas region for at least 15,700 years.

Southeastern California to Baja California Sur and eastward to Texas and northern Mexico.

OP: Near Bonito Well, 9 Apr 1941, *McDougall 59*. Alamo Canyon (Mulroy 1971). Hills above Aguajita Spring, *Warren 10 Nov 1983*. Quitobaquito, *Beale 23 Feb 1986* (ORPI). †Puerto Blanco Mts, on ridge, leaves, 2160 & 7580 ybp.
CP: Tule Tank, *Vorhies 17 Apr 1924*. Hills E of Papago Well, 26 Mar 1932, *Shreve 5924*. O'Neill Hills, *Darrow 14 Apr 1941*. Sheep Mt, 18 Feb 1979, *McLaughlin 1940*.
TA: W end Cipriano Pass, 12 Feb 1977, *Reeves R5431* (ASU). Tinajas Altas, ridge above tanks, 1420 ft, 26 Nov 2004, *Felger 04-91*. †Butler Mts, stems, leaf fragments, 740 & 8570 ybp. †Tinajas Altas, leaf fragments, seeds, 5860 to 15,680 ybp (5 samples).

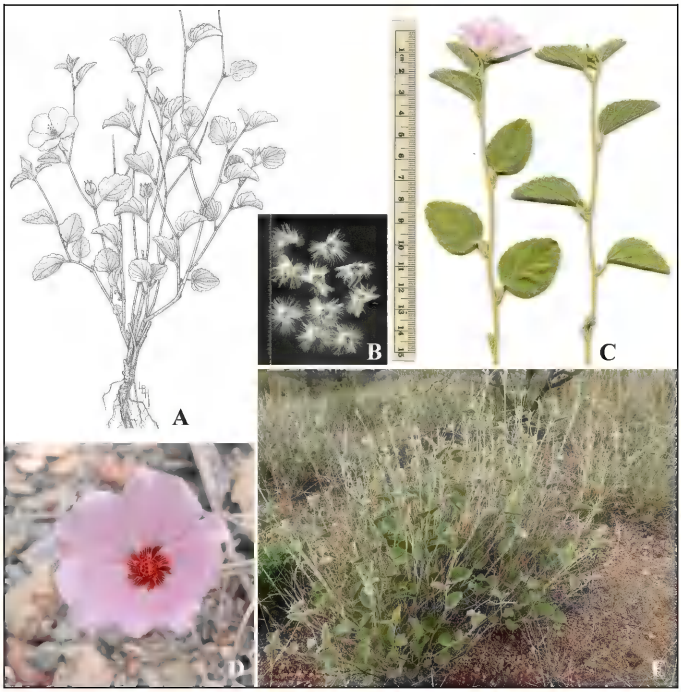

Figure 15. *Hibiscus denudatus*. (A) By Lucretia Breazeale Hamilton. (B) Boulder Canyon, 30 Sep 2014. (C) Teddy Bear Pass, Ajo Mountain Drive, 30 Sep 2014. (D) Waterman Mts, Ironwood Forest National Monument, 23 Feb 2014. (E) Salero Ranch, Santa Cruz Co., 21 Aug 2013. Photos D & E by Sue Carnahan.

Horsfordia – Velvet mallow

Tall spindly shrubs; densely stellate pubescent. Pedicels jointed but sometimes obscurely so, the joint best developed at fruiting time. Epicalyx absent. Fruit a schizocarp, the mericarps separating at maturity, 1–3-seeded, the lower chamber indehiscent with firm, wrinkled walls and a single tightly held seed, the upper chamber dehiscent, splitting into expanded membranous wings. One or both species in the flora area has been in Organ Pipe for more than 5200 years.

Southwestern USA and northwestern Mexico; 4 species.

1. Petals pinkish or sometimes nearly white when fresh, drying bluish to pale lavender; larger leaves mostly broadly ovate and cordate (heart-shaped); mericarps 1-seeded…….. **Horsfordia alata**
1. Petals orange when fresh; larger leaves mostly lanceolate and not cordate at base; mericarps 2 or 3-seeded…….. **Horsfordia newberryi**

Horsfordia alata (S. Watson) A. Gray
Pink velvet-mallow. Figure 16.

Sparsely branched slender shrubs often 2–3.5 m tall; often grayish pubescent; branches often at nearly right angles to the main stem. Leaves velvety, larger ones 6–10+ cm long, the petioles prominent, the blades usually broadly ovate, cordate at the base, often relatively thick, but new-growth summer-fall leaves often thin and scarcely or not at all cordate (uppermost leaves of flowering branches often lanceolate). Petals 14–18+ mm long, white to pale pink or pale lavender, drying bluish to pale lavender. Filaments, anthers, and style white, or free portion of filaments pale lavender; stigma often dark reddish purple. Fruits 10–15 mm wide. Mericarps 1-seeded, the upper chamber forming ovules but these aborting. Reproductive at various seasons.

Mountains and hills, and often along larger washes and arroyos, and sometimes along small washes; rocky to sandy-gravelly soils. Common in the Tinajas Altas Mountains and western half of Cabeza Prieta, less common eastward to the southwestern part of Organ Pipe.

Figure 16. *Horsfordia alata.* Mex Hwy 8, 11 km SW of Sonoyta, between the Sierra Cubabi and Sierra Los Tanques, Sonora: (A) 28 Mar 2013; (C) 7 Mar 2009; (D) 7 Sep 2014; (E) 18 Mar 2015. (B & F) W slope of Sierra Cubabi, Sonora, 6 Feb 2014.

Southwestern Arizona, northwestern Sonora, southeastern California, and both Baja California states. This is one of the tallest mallows in the deserts of western North America and is found in very arid regions.

OP: 3 mi W of Quitobaquito, 13 Nov 1978, *Bowers 1526*. Corner Well, 3 Dec 1990, *Felger 90-579*.
CP: Tule Tank, 26 Apr 1932, *Shreve 5932*. Pinacate Plateau, *Goodding 13 Feb 1942*. Heart Tank, 14 Apr 1964, *Niles 350*. Buckhorn Tank, 14 Jun 1992, *Felger* (observation).
TA: Tinajas Altas, 17 Apr 1948, *Kurtz 1158*. Camino del Diablo, E of Raven Butte, 10 Jan 2002, *Felger* (observation).

Horsfordia newberryi (S. Watson) A. Gray
Orange velvet-mallow. Figure 17.

Slender shrubs, usually several times taller than wide and few-branched, to 2.5+ m tall, often considerably shorter; often yellowish pubescent. Leaves velvety, larger ones 5.5–10 (15) cm long, the petioles prominent, the blades often rather thick, lanceolate, not cordate at base or scarcely so in some larger leaves. Petals bright yellow-orange, 7–8+ mm long. Fruits 8–15 mm wide. Lower mericarp chamber 1-seeded, the upper chamber 1- or 2-seeded. Reproductive at various seasons, except during coldest and driest weather.

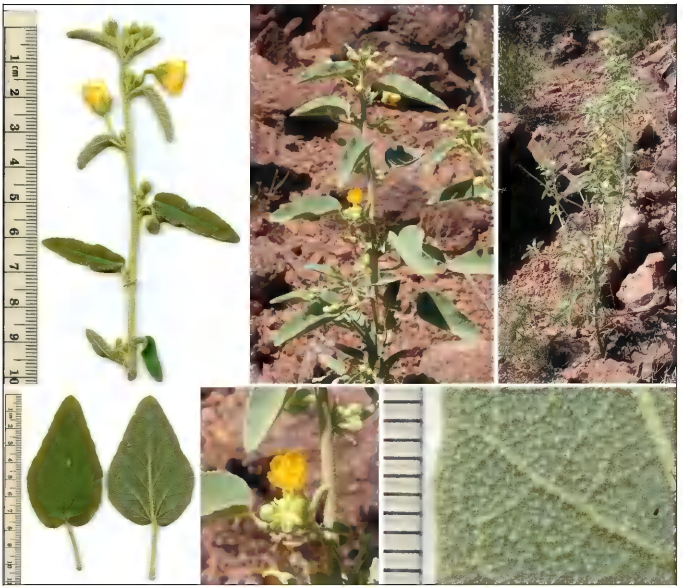

Figure 17. *Horsfordia newberryi*. SE-facing slope of the Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 18 Feb 2015.

Rocky slopes on hills and mountains, sometimes to their summits, and especially on arroyo and canyon sides; through most of the flora area.

Southwestern Arizona, northwestern Sonora, southeastern California, and both Baja California states.

OP: Pitahaya Canyon, *Nichol 23 Feb 1939.* Quitobaquito, 18 Mar 1945, *Darrow 2411.* Santa Rosa Mts, *Rutman 29 Aug 2001* (ORPI).
CP: Tule Tank, 6 Apr 1979, *Lehto 23549* (ASU). Canyon at Agua Dulce Tank, 13 Jun 1992, *Felger 92-571.* Cabeza Prieta Peak, S. facing side of summit, 2550 ft, 24 Mar 1995, *Yeatts 3661* (CAB). Heart Tank, 14 &15 Jun 1992, *Felger* (observation).
TA: Borrego Canyon, 16 Jun 1992, *Felger* (observation). Fortuna Mine, along Camino del Diablo, *Halse 31 Mar 1973.*

Horsfordia sp./spp.
OP: †Puerto Blanco Mts, on ridge, leaf fragments, mericarps, modern (30) to 5240 ybp (8 samples).

***Malva**
Annual and perennial herbs. Native to the Old World (*Malva* sensu stricto) and North America by inclusion of some *Lavatera* (Hill 2015): 30+ species.

***Malva parviflora** Linnaeus
Cheeseweed; *malva, quesitos*; tas ha:hag, ha:hag cu'igkam. Figure 18.

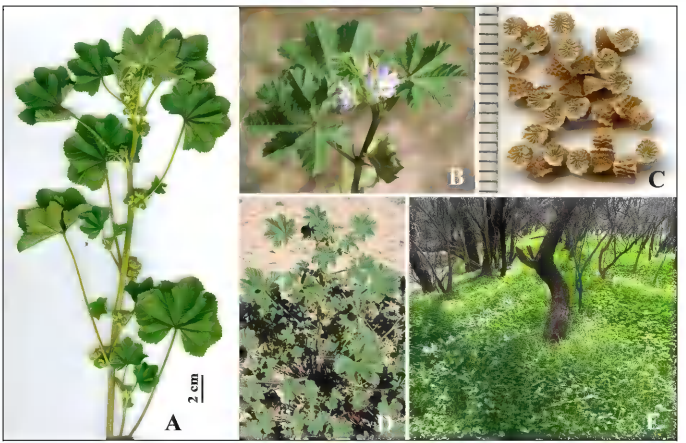

Figure 18. *Malva parviflora.* (A) Ajo, 13 Feb 2005. Pinacate Junction, Pinacate Biosphere Reserve, Sonora: (B & C) 7 Mar 2015; (D) 5 Mar 2015. (E) Hot Shot Tank, NE of Ajo, 6 Feb 2005.

Winter-spring ephemerals with a well-developed taproot; glabrate to moderately pubescent with soft, mostly stellate white hairs. Petioles longer than the blades, the blades nearly orbicular to kidney-shaped, usually palmately 5- or 7-lobed. Flowers 1 to several in leaf axils; epicalyx of slender bractlets. Petals 5 mm long, white with a pale pink-lavender tinge, obovate, and notched at the tip. Fruit a schizocarp, depressed-globose, 6–7 mm wide; mericarps about 10, in a torus-shaped ring, 1-seeded, indehiscent, dispersing individually at maturity.

Organ Pipe in localized, disturbed habitats. It is a common urban and agricultural weed in nearby Sonora, a potential source of immigration.

Native to Eurasia and naturalized around the world.

This weedy plant is cooked as greens in many parts of the world, and the fruits are also edible (Bean & Saubel 1972; Kirk 1970; Yanovsky 1936). Russell's (1908) report of this species as a Pima emergency food was based on misidentification of *Eremalche exilis* (Rea 1997).

OP: Quitobaquito, 14 Apr 1963, *Felger 7663*. Abundant weed near old corral in Alamo Canyon, 16 Feb 1979, *Bowers 1563*.

Malvastrum

Annual and perennial herbs and small shrubs. Americas; 15 species.

Malvastrum bicuspidatum (S. Watson) Rose subsp. **bicuspidatum**
[*M. tricuspidatum* var. *bicuspidatum* S. Watson]. Figure 19.

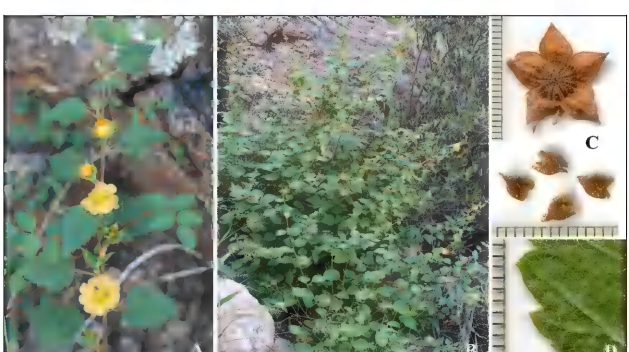

Figure 19. *Malvastrum bicuspidatum* subsp. *bicuspidatum*. (A & B) Bull Pasture Trail, 24 Sep 2006. (C & D) Alamo Canyon, 3 Sep 2014.

Small shrubs or subshrubs with slender, firm stems. Herbage stellate-pubescent. Leaves 2–6 cm long, petioled, the blades ovate, the margins serrate. Epicalyx of 3 lanceolate bracts. Calyx 5-

lobed, 6–8 mm long. Petals, stamens, and styles pale yellow-orange. Petals 6–8 mm long. Fruits schizocarps, 6–7 mm wide, globose-depressed, flattened at each end (oblate). Mericarps 9–12, indehiscent, horseshoe-shaped, the lateral walls ribbed, with 2 dorsal cusps, and 1-seeded. Seeds glabrous.

Ajo and Diablo mountains, especially at higher elevations, in canyons and on rocky slopes.

This subspecies occurs eastward and northward in south-central Arizona and in northwestern Mexico including Baja California Sur, Chihuahua, Durango, Sinaloa, and Sonora but is generally absent from the desert in western Sonora. Three other subspecies occur farther south in Mexico.

OP: Ajo Mts, *Goodding 21 Nov 1934*. Alamo Canyon, 13 Sep 1941, *Goodding 300-41*. W side of Montezuma's Head, *Van Devender 10 Mar 1978*. Arch Canyon, 2 Dec 1990, *Felger 90-553*. Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-27*.

Malvella

Small, scurfy and herbaceous perennials from deeply seated roots, and spreading by rhizomes; growing and reproductive with sufficient soil moisture during warmer months. Herbage gray or silvery with appressed stellate hairs or peltate and often ciliate (fringed) scales. (In these lepidote scales, the basal portions of the radii are webbed like an umbrella with protruding ribs.) Leaves petioled; base of leaf blades conspicuously asymmetric. Epicalyx of 1–3 bractlets, quickly deciduous or absent. Petals white or pink, with stellate hairs on portions exposed in bud. Fruit a schizocarp, globose-depressed, flattened at each end, the mericarps indehiscent and 1-seeded.

Southwestern USA and Mexico with 3 species and one in the Mediterranean region.

1. Plants with mostly stellate hairs and some peltate scales; leaf blades nearly as wide to wider than long..... **Malvella leprosa**
1. Plants with silvery, peltate scales; leaf blades narrowly triangular, conspicuously longer than broad. ..... **Malvella sagittifolia**

Malvella leprosa (Ortega) Krapovickas

[*Sida leprosa* (Ortega) K. Schumann. *Malva hederacea* Douglas. *S. leprosa* var. *hederacea* (Douglas) K. Schumann ex Clement].

Alkali mallow. Figure 20.

Perennials often propagating from branching rhizomes. Stems, leaves, and calyces densely covered with stellate hairs, and calyces, upper surfaces of leaf blades, and often the stems also with peltate scales. Stems 6–30 cm long, erect, or becoming spreading and decumbent; larger stems 1.3–2 mm diameter. Leaf blades broadly ovate, about ⅔ as wide as long to orbicular and broader than long (nearly kidney-shaped) or asymmetrically triangular-ovate, 1.6–4 × 2–5 cm, the margins toothed. Epicalyx of linear bractlets, shorter than the calyx, sometimes seen on buds or flowers, usually difficult to see and very quickly deciduous. Calyx 8–11 mm long, the lobes broadly ovate, acute at tip. Petals pink, 1.5–1.8 cm long. Fruits red-brown, 6–7 mm in diameter.

Locally common in seasonally wet, hard-packed silty-clay soils of the large playas of Cabeza Prieta near the Mexico border.

Washington and Idaho to central Mexico, and in South America; introduced elsewhere, including Australia. It is considered a noxious weed in Arizona and California.

CP: Las Playas: 11 Apr 1978, *Reeves 6811* (ASU); 28 Nov 2001, *Felger 01-563*.

Figure 20. *Malvella leprosa*. Playa NNW of Ortega Represo (S of Las Playas), Sonora, 11 Apr 2014.

Malvella sagittifolia (A. Gray) Fryxell
[*Sida lepidota* A. Gray var. *sagittifolia* A. Gray]
Arrowleaf alkali mallow. Figure 21.

Perennials from a relatively deep, somewhat thickened taproot; propagating from branching rhizomes. Stems, leaves, and calyx dotted with silvery peltate scales, the margins erose-dentate (fringe-toothed). Stems slender, spreading and becoming nearly prostrate, 4–30 cm long. Leaf blades triangular, much longer than broad, 1.5–4.5 × 0.5–1.5 cm, with sagittate ("eared") basal lobes, the tip acute, the margin otherwise entire to few- or minutely toothed. Epicalyx absent, or sometimes vestigial and quickly deciduous below young buds. Petals mostly white, 1–1.3 cm long, lower (outer) surface of each petal with a pink pie-shaped wedge dotted with stellate hairs where the corolla is exposed in bud. Stamens and styles white, the stigmas rounded, dot-like, and bright red. Fruits 5–6 mm in diameter. Reproducing during warmer months. The plants are generally more delicate with more slender stems and leaves than *M. leprosa*.

Abundant in seasonally wet, hard-packed silty soils of playas at the southern margin of Cabeza Prieta.

Southern Colorado to Arizona, Sonora, western Texas, Coahuila and Durango.

CP: Pinta Playa, *Simmons 4 Oct 1964*. Las Playas, 28 Nov 2001, *Felger 01-564*. Dos Playas, 7 Apr 1979, *Lehto 23595* (ASU).

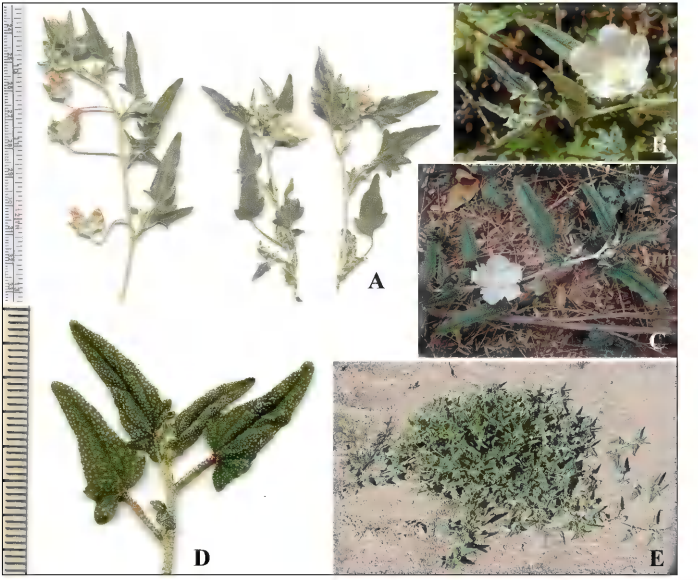

Figure 21. *Malvella sagittifolia.* Small playa SE of Pinacate Junction, Pinacate Biosphere Reserve, Sonora: (A) 17 Mar 2014; (D) 7 Mar 2015; (E) 5 Mar 2014. (B) Ortega Represo (S of Las Playas), 11 Apr 2014. (C) Cerro Proveedora, seasonally flooded, trail along cattle pasture, Rancho Puerto Blanco, Caborca, Sonora, 1 Mar 2015, photo by Sue Carnahan (SEINet).

Rhynchosida

Two species including *R. kearneyi* in Bolivia

Rhynchosida physocalyx (A. Gray) Fryxell
[*Sida physocalyx* A. Gray]. Figure 22.

Perennial herbs from a single, thick carrot-shaped root, the stems ascending to trailing, with scattered coarse stellate hairs. Growing and reproductive during warmer months with sufficient soil moisture. Leaves 2–5 cm long, the blades mostly lanceolate to broadly ovate or oval, with toothed and ciliate margins. Flowers solitary in leaf axils. Epicalyx absent. Calyx deeply 5-lobed, the lobes overlapping, cordate, conspicuously angled, and enlarging to become inflated and enclosing the fruit. Petals pale yellow, 5–8 mm long, the anthers orange and conspicuous. Fruit a schizocarp, 8–9 mm wide, globose depressed and flattened at each end, blackish and glabrous. Mericarps hard and indehiscent, the sides reticulate-veined, with a single seed.

Valley of the Ajo, usually as an understory plant in xeroriparian washes. Apparently rare, uncommon, or overlooked in the flora area, where it is at its farthest intrusion into the desert.

Eastward in southern and central Arizona to Texas and Oklahoma, southward in Mexico to Puebla, and disjunct in South America.

OP: Cherioni Wash, *Warren 10 Nov 1983*. E branch of Cuerda de Leña Wash at N boundary of Monument, *Rutman 20 Aug 2001* (ORPI).

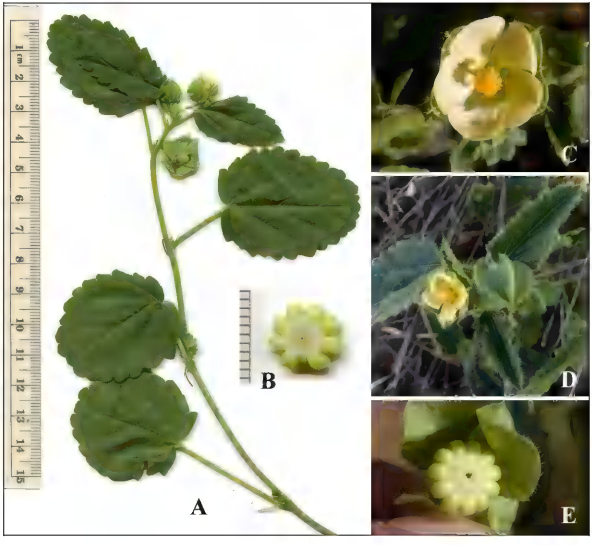

Figure 22. *Rhynchosida physocalyx*. (A & B) 8th Street and Campbell Ave, Tucson, 28 Sep 2014. (C & E) Sierra Vista Trail, W side of Organ Mts, Doña Ana Co., NM, 28 Sep 2008, photos by Patrick Alexander (SEINet). (D) Quail Springs Ranch, SW of Cottonwood, Yavapai Co., 28 Apr 2013, photo by David C. Thornburg (SEINet).

Sida

Annual and perennial herbs and shrubs. Nearly worldwide, but not in Europe, 150 species.

Sida abutifolia Miller

[*Sida filicaulis* Torrey & A. Gray. *S. procumbens* Swartz]. Figure 23.

Small annuals/ephemerals or mostly weakly perennial herbs, generally low-growing with slender and often procumbent stems. Herbage and calyces densely pubescent with short, stellate hairs, and also with simple, spreading hairs except on the leaf blades. Larger leaves often 1.5–5 (6)

cm long; petioles one-half to as long or longer than the blades. Leaf blades ovate to oblong, generally more than twice as long as wide, or sometimes linear-ovate to linear-elliptic on vigorous new growth, usually cordate at base, the margins crenate-toothed. Epicalyx absent. Flowers solitary in leaf axils on slender pedicels; calyx 4–5 mm long, the lobes ovate with an acuminate tip; petals 5–6 mm long, broadly obovate and shallowly notched at tip, pale yellow to pale yellow-orange, darker yellow basally like the anthers and stigmas giving a darker yellow center to the flower. Fruit a schizocarp, conical and flattened at each end, 4–5 mm wide. Mericarps 5, usually with 2 short, apical spines, 1-seeded. Seeds glabrous. Probably flowering all year except the coldest months and during extreme drought, but especially with summer rains. The flowers open during the afternoon.

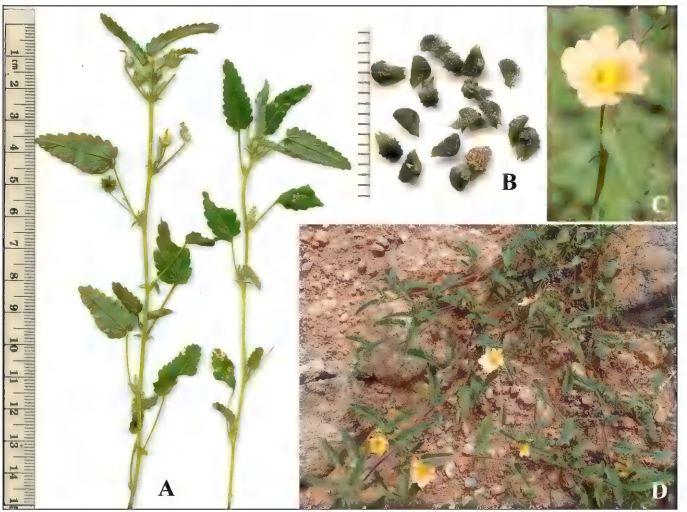

Figure 23. *Sida abutifolia*. Hwy 85, roadside ditch near mile 62: (A) 1 Aug 2014; (C) 14 Sep 2006. (B) Foothills of Diablo Mts, 30 Sep 2014. (D) Salero Ranch, Santa Cruz Co., 1 Aug 2013, photo by Sue Carnahan.

Ajo and Diablo mountains, especially at higher elevations and one unusual record at the Visitor Center.

Eastward in southern Arizona; southern USA to northern South America and West Indies.

OP: Saddle between Boulder and Arch Canyon, 3800 ft, 3 May 1978, *Bowers 1287* (ORPI). Visitor Center flower bed, *Beale 25 Mar 1988* (ORPI). Alamo Canyon, 29 Mar 2003, *Felger 03-423.* Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-294.* Arch Canyon, shaded slope N of the arch, 12 Sep 2014, *Rutman 20140912-4.* Diablo Mts, W of Boulder Canyon near N end of Ajo Mountain Drive, 30 Sep 2014, *Rutman*, scan

Sphaeralcea – Globe mallow; *mal de ojo*

Ephemerals and perennial herbs to shrubs (usually flowering in the first season or year), with stellate hairs. Leaves petiolate. Epicalyx of 3 filiform bracts. Petals of various colors. Fruit a schizocarp, the mericarps 1–3-seeded, with a ventral notch; each mericarp differentiated into (1) an upper, dehiscent section with smooth carpel walls and spreading apart at maturity, the seed(s), if present, falling away early, and (2) a lower, indehiscent section, the body of the mericarp with a reticulate surface and retaining the seed(s): thus 2 strategies for seed dispersal (Figures 24 & 25). Seeds kidney-shaped. Globe mallows have been part of the regional flora for more than 11,300 years.

Americas, mostly in arid regions; 50 species (La Duke 2015).

Sphaeralcea plants are self-incompatible but with an open breeding system capable of producing hybrids between numerous species (Dreher 2014). Taxonomy of *Sphaeralcea* can be difficult, due to many intermediate forms. For example, if enough specimens are at hand, *S. ambigua*, *S. angustifolia*, and *S. emoryi* can be seen to form a seamless continuum.

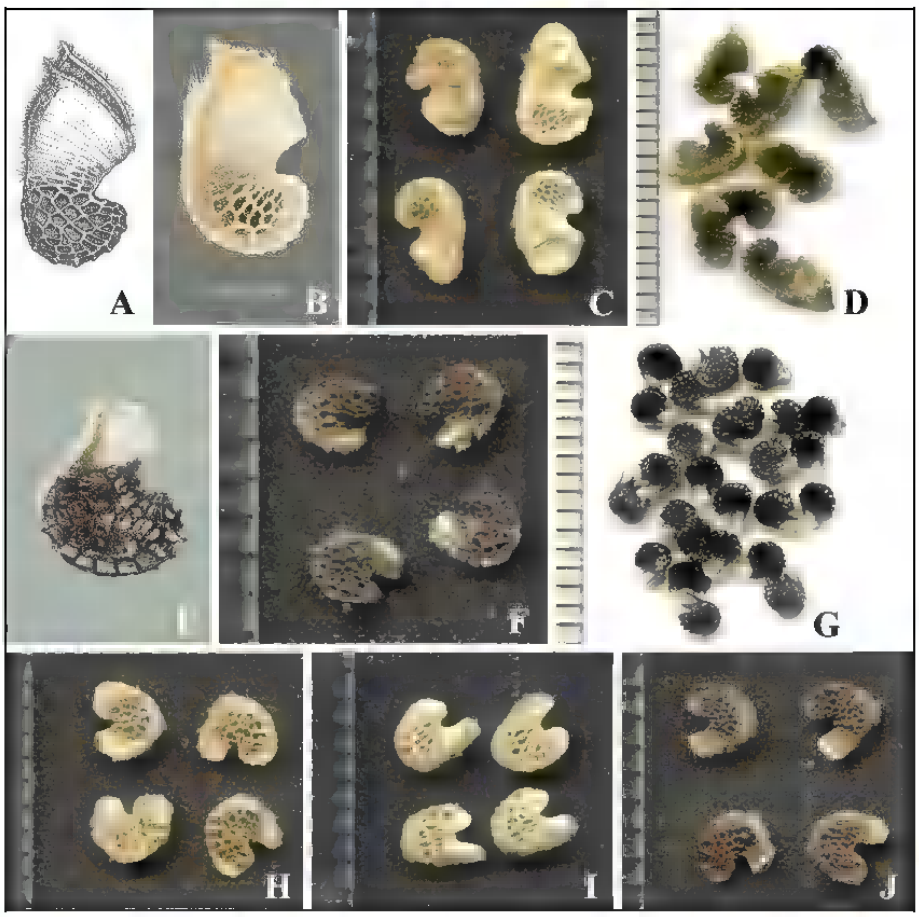

Figure 24. *Sphaeralcea* mericarps. ***S. ambigua***: (A) By Lucretia Breazeale Hamilton; (B) W of Picketpost Mtn, Pinal Co., *Davis 20 Apr 2012*; (C) Cuerda de Leña Wash, 13 Jun 1978, *Bowers 1345*; (D) Hwy 86, mile 62, E of Why, 5 Apr 2015, *Rutman*, scan. ***S. coulteri***: (E) Hayden Butte, Maricopa Co., *Davis 25 Mar 2013* (ASU); (F) Pinacate lava flow, Yuma Co., 20 Mar 1992, *Harlan 58*; (G) Ajo, 23 Mar 2015, *Rutman*, scan. ***S. orcuttii***: (H) Dunes NE of Sierra del Rosario, Sonora, 4 Mar 1972, *Felger 20436*; (I) 30 mi N of San Felipe, Baja California, 17 Mar 1960, *Wiggins 15774*; (J) Dunas costeras, Bahía de Adair, Sonora, *Ezcurra May 1981*.

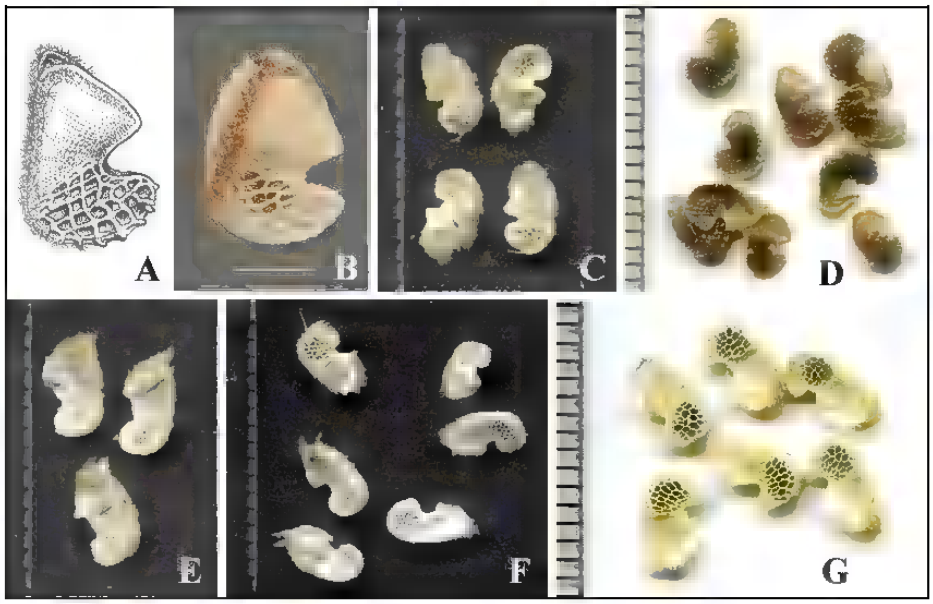

Figure 25. *Sphaeralcea* mericarps. ***S. emoryi***: (A) By Lucretia Breazeale Hamilton; (B) Pyramid Peak Parkway, between Sonoran Mountain Ranch Rd and 67th Ave, Maricopa Co., *Davis 28 Apr 2012*; (C) Floodplain at confluence of Alamo and Cherioni washes, *Warrren 10 Nov 1983*; (D) Midway Wash, Maricopa Co., 18 Mar 2015, *Rutman*, scan. ***S. laxa***: (E) Alamo Canyon, 19 Apr 1942, *Cooper 747*; (F) Estes Canyon wash bed, 0.5 mi upstream from trailhead, 17 May 2015, *Rutman*, scan; (G) Alamo Canyon, 0.5 mi upstream from campground, 4 Apr 2015, *Rutman*, scan.

These plants have been widely used medicinally, especially the roots for eye ailments, although the herbage is well known to cause eye irritations, as indicated by the common name *mal de ojo* in Mexico (Felger 2007; Felger & Moser 1985; Kearney & Peebles 1960; Rea 1997). La Duke (2015: 357), who has spent decades studying the genus, writes: "*Sphaeralcea* is often collected and somewhat difficult to identify. The species boundaries are not always sharp because there is frequent hybridization, polyploidy, and morphological variation in response to environmental conditions, particularly rainfall. Plants growing in Arizona are particularly difficult to identify."

In the following keys and descriptions, mericarp measurements are the length of the longest axis.

1. Ephemerals/annuals (sometimes may appear perennial), often taller than wide; mericarps 1-seeded, the dehiscent section short and stubby, less than half as long as the body.
…… **Sphaeralcea coulteri/orcuttii**
1. Perennials; mericarps 2- or 3-seeded, the dehiscent section more than half as long as the body.

2. Leaves deeply and notably 3-lobed; inflorescence an open and few-flowered panicle
…….. **Sphaeralcea laxa**
2. Leaves not especially deeply lobed; inflorescence an interrupted, many-flowered raceme or panicle.

3. Mostly globose bushes, often at least as broad as tall; leaf blades as long as or slightly longer than wide; petals orange or sometimes pinkish; mericarps 2-seeded…….. **Sphaeralcea ambigua**
3. Plants often as tall to much taller than broad; leaf blades usually conspicuously longer than wide; petals reddish orange; mericarps 2- or 3-seeded …….. **Sphaeralcea emoryi**

Sphaeralcea ambigua A. Gray subsp. **ambigua**
Desert globe-mallow; *mal de ojo*. Figures 24A–D & 26.

Bushy perennials, becoming moderately woody at base, often globose and reaching 1 (1.3) m but usually smaller. Stems and upper leaf-blade surfaces often with a yellow cast, hairs of lower surfaces usually whiter. Leaf blades mostly 1.8–6 cm long, more or less ovate, often more or less 3-lobed, thinner and larger during more favorable conditions and thicker, smaller, and often wrinkled during drier conditions, the margins variously toothed to wavy. Inflorescences often paniculate. Flowers often relatively large; petals orange, or sometimes pink, (1.5) 2–3+ cm long; anthers and stigmas usually light colored (often white), or sometimes dark purple. Mericarps 2-seeded, light colored, (3) 4–6.4 (7.1) mm long, the upper, dehiscent section larger than the body; mericarps usually rounded at apex, or sometimes with a small apical cusp. Flowering at various seasons, especially in spring.

Figure 26. *Sphaeralcea ambigua* subsp. *ambigua*. (A) Hwy 86 mile 62, 22 Feb 2014. (B) Hat Mountain, Sauceda Mts, 22 Mar 2014. (C) Victoria Mine, 1 Apr 2010. (D & E) Knucklehead Wash at base of Childs Mountain, 16 Mar 2015. (F) Twin Peaks, 19 Mar 2015. (G) Just E of Charlie Bell Pass, 16 Mar 2015.

Mostly on rocky slopes, upper bajadas, and washes, but also on well-drained soils of valley plains and roadside along Highway 85; widespread across the flora area. It was in the Ajo Mountains 1200 years ago.

Sphaeralcea ambigua, with 4 subspecies, occurs in southwestern USA and northwestern Mexico. Subsp. *ambigua* is a desert plant and the most widespread of the several infraspecific taxa; Arizona, southwestern Utah and southern Nevada to southeastern California, northwestern Sonora, and the Baja California Peninsula.

OP: 10 mi S of Bates Well, 5 Mar 1940, *Benson 9924*. Quitobaquito, flowers scarlet, 5 Mar 1940, *Peebles 14552*. Ajo Mts, main canyon N of Alamo Canyon, steep rocky, S-facing slopes, 31 Mar 1948, *Gould 4692*. Puerto Blanco Mts, rocky slope above Dripping Springs, 16 Apr 1952, *Parker 7942*. 4.5 mi N of Pozo Nuevo, in wash at roadside, 30 Mar 1978, *Bowers 1145*. Cuerda de Leña Wash near N boundary, 13 Jun 1978, *Bowers 1345*. 2.5 mi E on Puerto Blanco Drive, arroyo, 12 Apr 1986, *Houk 20 & Carter*. Puerto Blanco Drive, 2.4 mi W of Ariz Hwy 85, margins of wash, 19 Jun 1989, *Felger 89-229A*. †Alamo Canyon, mericarps, 1150 ybp.

CP: Tule Tank, 21 Mar 1933, *Shreve 6223*. Tule Mts, 23 Mar 1935, *Kearney 10882*. Small hill near Sheep Mtn, 11 mi W of Organ Pipe W boundary, along stream at base of hill, with *S. emoryi, S. laxa*, 21 Mar 1979, *Mason 3370*. Top of rocky hill S of O'Neil's Grave, 13 Mar 1983, *Mason 3603*. Lava and sand on Pinacate Lava flow, inside crater, taller, redder species, 21 Mar 1992, *Harlan 59* (other species = *S. coulteri*, *Harlan 58*). Charlie Bell Road 0.4 mi W of E boundary of Refuge, small arroyo, 9 Apr 1993, *Felger 93-331*. Daniels Arroyo at Charlie Bell Rd, 9 Apr 1993, *Felger 93-364*. E side Pinacate lava and E Pinta Sands, low dunes encroaching lava field, 11 Apr 1993, *Felger 93-437*. Cabeza Prieta Peak, N facing side of summit, 2550 ft, 24 Mar 1995, *Yeatts 3650*. 0.5 mi S of Sunday Pass, 2600–2700 ft, granite boulders at ridge-top, *Cain 15 Nov 2003*.

TA: 1 mi N of Tinajas Altas, Tinaja Altas Mts, 17 Apr 1948, *Kurtz et al 1173*. Tinajas Altas, just N of tanks, 1800 ft, 10 Mar 1980, *Reichenbacher 481*. Vicinity of Tinajas Altas, 1200 ft, *Van Devender 5 Mar 1983*. Tinajas Altas, 1200 ft, *Van Devender 25 Mar 1983*. Tinajas Altas Mts, canyon bottom in upper canyon, high canyon valley, 1530 ft, 26 Oct 2004, *Felger 04-78* (ARIZ, ASU). Tinajas Altas Mts, below Raven Tank, 1220 ft, deep xeroriparian canyon, 29 Mar 2010, *Felger 10-240*.

Sphaeralcea coulteri (S. Watson) A. Gray
Annual globe-mallow; *mal de ojo*; hadam tatk, ñiatum. Figures 24E–G & 27.

Winter-spring ephemerals with a well-developed taproot, sometimes germinating as early as September, and sometimes also growing with summer rains; extremely variable in size, from less than 10 cm to 1 (2) m tall, the stems slender to stout, often distinctly reddish, sometimes appearing perennial and perhaps sometimes surviving one year or more. Leaf blades highly variable in size, thin and green when vigorously growing, or thick, wrinkled and yellowish in drought, about as broad as long to longer than wide, ovate to orbicular, often shallowly 3-lobed and variously toothed, or hastate (2 large, "eared" lobes at base). Flowers often crowded in slender, many-flowered terminal inflorescences; flowers opening in early morning, sometimes around 8 a.m. The petals yellow-orange to orange, 5–10 (12) mm long. Anthers yellow. Mericarps 1-seeded, 1.7–2.4 (2.6) mm long, about as long as wide; the indehiscent part blackish (light-colored when immature), the dehiscent (upper) part whitish and much smaller than the body.

Seasonally abundant across the flora area, often carpeting the springtime desert with orange. Desert flats, bajadas, washes, canyons, playas, and dunes. This is the most common ephemeral mallow in the region.

Southern Arizona to Sinaloa, and southeastern California to Baja California Sur.

OP: Growler Valley, 20 Mar 1933, *Shreve 6204*. Alamo Canyon, *Nichol 26 Mar 1939*. 10 mi S of Bates Well, 5 Mar 1940, *Benson 9919*. Near Dripping Springs, 16 Apr 1952, *Parker 7943*. 10 mi NW of Headquarters, Dripping Springs Drive, 16 Mar 1965, *Niles 523*. Pozo Nuevo, 30 Mar 1978, *Bowers 1111*.

Floodplain confluence of Alamo and Cherioni Washes, *Warren 10 Nov 1983.* Aguajita, *Beale 8 Apr 1988* (ORPI). W side Sierra Santa Rosa, base of mountain, 12 Mar 2003, *Felger 03-377.*

CP: Near Tule Tank, 23 Mar 1935, *Kearney 10900.* Charlie Bell Well, Growler Mts, *Johnson 26 Mar 1960.* Old ranch site 4.7 mi NE of Tule Well, 28 Mar 1985, *McLaughlin 2978.* Upland, 0.2 mi W of San Cristobal Wash, 20 Mar 1992, *Harlan 013.* Lava and sand on Pinacate lava, shorter, lighter orange than adjacent species [*S. ambigua*, *Harlan 59*], 20 Mar 1992, *Harlan 058.* Las Playas, clayish soil with mesquite shrubs, 11 Jan 2002, *Felger 02-38.* 5 mi N of Tule Tank on road to Christmas Pass, large wash, 2 Feb 1992, *Felger 92-74.* Mohawk Valley, 12 mi of road between Christmas Pass and the N Refuge Boundary, miles of this plant, 13 Apr 1992, *Harlan 263.*

TA: Coyote Water, banks of wash, 1.5–1.8 (2) m tall, few-branched erect stems, 21 Feb 2005, *Felger 05-141.* High Tanks Gate, 18 Mar 1998, *Felger 98-111.*

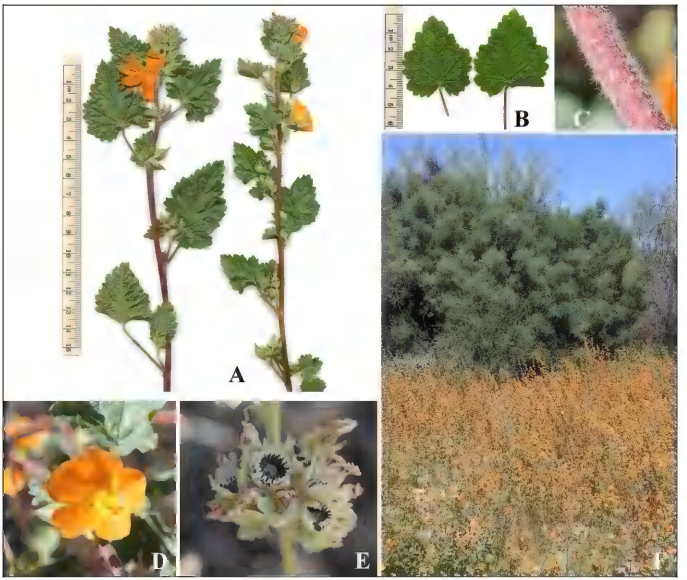

Figure 27. *Sphaeralcea coulteri.* (A) Wash near Hwy 85, N boundary of Organ Pipe, 14 Feb 2015. (B & E) Hwy 86 near mile 62, E of Why, 5 Apr 2015. (C & D) Kuakatch Wash near Kuakatch Village, 3 Mar 2014. (F) La Abra Plain, S Puerto Blanco Drive, 15 Mar 2015.

Sphaeralcea emoryi Torrey ex A. Gray subsp. **emoryi**
Emory globe-mallow; *mal de ojo*. Figures 25A–D & 28.

Ephemerals to short-lived perennials, herbaceous to subshrubs 0.5–2+ m tall. Stems erect to floppy and curving in shaded habitats and with age. Leaves 4–14.5 cm long, highly variable, the blades conspicuously longer than wide and broadest near the base, 3-lobed and relatively thin, or

ovate and thicker with drier conditions; petioles prominent. Inflorescences slender, the flowers in glomerate clusters crowded at nodes. Petals reddish orange, 1.4–1.8+ cm long. Anthers light colored, white or yellow, or sometimes medium-dark colored, stigmas light colored, occasionally dark. Mericarps 2- or 3-seeded (if 1-seeded, then other(s) fell out), light colored, longer than wide with a deep notch; the dehiscent section about as wide as the body; indehiscent part ca. 40% of carpel, with small windows in the coarse reticulations. Mericarps 2.6–7.1 mm long including short to long cusp 0.3–1.2 mm long. Flowering with spring and summer-fall rains.

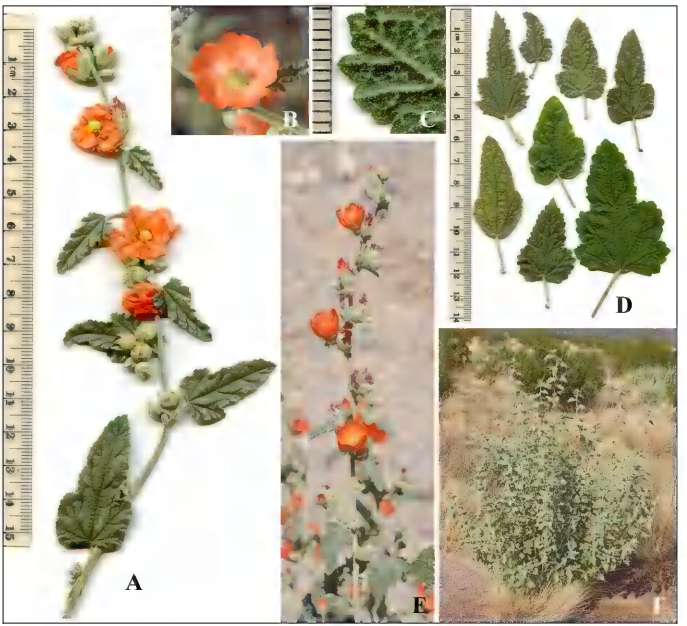

Figure 28. *Sphaeralcea emoryi*. (A, C & D) Ajo, 13 May 2015. (B) Hwy 86, San Simon, Tohono O'odham Reservation, 4 Mar 2014. (E) Darby Wash near Hwy 85, 6 May 2006. (F) E of Hwy 85, S of Crater Range, 4 Dec 2014.

Playas, washes, canyon bottoms, and charcos, often on finer-textured soils; widely scattered and generally localized in Organ Pipe and the eastern part of Cabeza Prieta, the southern margin of Cabeza Prieta at Las Playas and vicinity, and the Lechuguilla Valley at the Camino del Diablo.

Arizona to Sinaloa, southern Nevada, southeastern California, and Baja California.

Although La Duke (2015) does not recognize infraspecific taxa of *Sphaeralcea emoryi*, there are two extremes that seem to warrant recognition. Subsp. *emoryi*, often occurring with arid conditions, tends to become tall, sometimes woody and pubescent with thicker, more rounded, and less deeply toothed/lobed leaves, and generally darker orange petals and whitish/cream anthers and stigmas and yellow pollen. The herbaceous ruderal, narrow-leaved and much less pubescent subsp. *variabilis* (Cockerell) Kearney usually has darker anthers and stigmas. Plants in the flora area are readily accommodated as subsp. *emoryi*, although in other regions there are often intermediates between the subspecies and with *S. ambigua*.

Sphaeralcea emoryi and *S. angustifolia* sometimes can be almost inseparable. Some specimens from the flora area have large, narrow lanceolate leaves resembling *S. angustifolia*. *Sphaeralcea angustifolia* has narrow, lanceolate leaves and the mericarps persistent on the column when the fruits are completely mature.

OP: Alamo Canyon, *Nichol 26 Mar 1939*. Near Quitobaquito, 5 Mar 1940, *Peebles 14556*. Between Williams Spring and Quitobaquito, 10 May 1979, *Bowers 1719*. Quitobaquito: 13 Apr 1963, *Felger 7650* (mixed collection *S. coulteri*); *Van Devender 30 Aug 1978* (2 sheets: ARIZ 219425 & 219427); Shade of cottonwoods, 23 Jul 1986, *Felger 86-206*; Semi-shade beneath cottonwoods, 26 Apr 1990, *Felger 90-90*. 10 mi S of Bates Well, 5 Mar 1940, *Benson 9921*. Armenta Well, in flooded area of *Larrea* flat, *Warren 16 Nov 1974*. Wash ½ mi N of Pozo Nuevo, 12 Apr 1978, *Bowers 1262*. Floodplain at confluence of Alamo and Cherioni washes, *Warren 10 Nov 1983*. Puerto Blanco Drive, 4.2 mi w of Hwy 85, arroyo among lower bajada, 3 Dec 1990, *Felger 90-572*.

CP: 11 mi W of ORPI boundary, 3 species of *Sphaeralcea* here, 4 Mar 1977, *Mason 3226*. E side of Agua Dulce Mts, in wash, alternate road to Papago Well, 21 Mar 1979, *Mason 3369*. Playa W of O'Neill Hills, *Harlan 20 Mar 1983*. Las Playas: 100% cover of ephemerals, 31 Jan 1992, *Felger 92-15*; 10 Apr 1993, *Felger 93-381*. San Cristobal Wash: 14 Sep 1992, *Felger 92-689* (2 sheets, ARIZ 300470 & 299028); 10 Apr 1993, *Felger 93-374*; 26 Mar 2010, *Felger 10-107* (ARIZ, ASU). Charlie Bell Road at W branch of Daniels Arroyo, riparian desertscrub, with *S. coulteri*, 10 Apr 1993, *Felger 93-361*. 1.4 mi W of Organ Pipe on Camino del Diablo-Bates Well Road, 26 Sep 2013, *Rutman 20130926-3*.

TA: Lechuguilla Valley, Camino del Diablo, S end of Coyote Wash, mesquite "forest," 28 Mar 2010, *Felger 10-167*.

Sphaeralcea laxa Wooton & Standley
Caliche globe-mallow. Figures 24E–G & 29.

Herbaceous perennials to 80+ cm tall, with sparsely leaved, spreading stems. Stems whitish, leaves canescent, stipules and bracts often pinkish. Leaves often 3–5 cm long, ovate-triangular, longer than wide, deeply 3-lobed with toothed margins, the middle lobe much longer than the lateral ones. Flowers often relatively large and set rather far apart on open, few-branched inflorescences. Pedicels relatively long. Petals bright orange, 1–1.5 cm long; filaments, anthers, and stigmas dark purple or dark reddish purple. Capsules truncate conical. Mericarps 2-seeded, 4.2–6.5 mm long, usually with a mucro or cusp to 0.2 mm long on the apical end of carpel. Mericarps notably longer than wide, the dehiscent part usually longer and wider than the indehiscent part, the indehiscent part often about 40% of the whole mericarp, with small windows and rather fine reticulations (like a fish net).

Common in the Ajo Mountains, canyons and mostly higher elevations, and occasionally elsewhere in Organ Pipe.

Northward and eastward in Arizona to western Texas and northern Sonora.

OP: Alamo Canyon: 13 Sep 1941, *Goodding 297-41*; 19 Dec 1945, *Goodding & Supernaugh 478-45*; Floor of canyon, alluvial wash, flowers rose-pink, 19 Apr 1942, *Cooper 747*; 12 Apr 1978, *Bowers 1252*. Estes Canyon, 2785 ft, 9 Apr 2005, *Felger 05-166*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-293*.

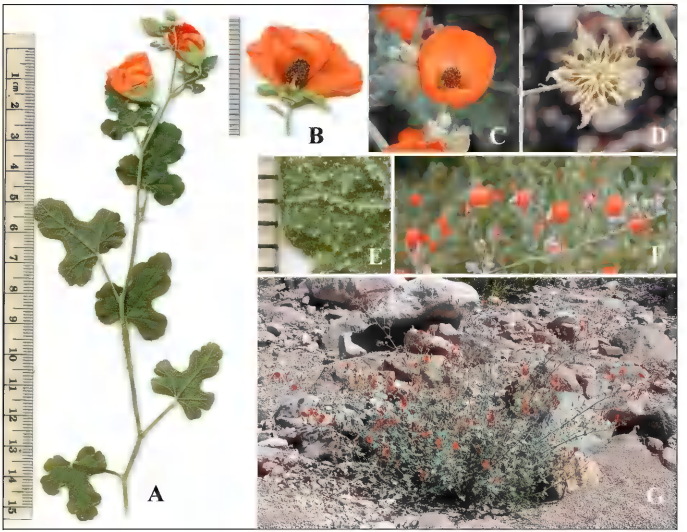

Figure 29. *Sphaeralcea laxa*. Alamo Canyon: (A & E) 3 Sep 2014; (D) 4 Apr 2015. Estes Canyon: (B) 22 Mar 2015; (F) 18 Mar 2005; (G) 7 Mar 2014. (C) Hwy 86 near Quijotoa, 22 Feb 2014.

Sphaeralcea orcuttii Rose
Figures 24H–J & 30.

Large, robust plants with erect-growing stems, often 1–2.5 m tall, resembling *S. coulterii*. These plants occur on stabilized dunes and sand flats in Cabeza Prieta, such as the Pinta Sands, as well as the adjacent Gran Desierto of northwestern Sonora and similar plants are found elsewhere in southwestern Arizona. *Sphaeralcea orcuttii* is otherwise known from northeastern Baja California and southeastern California.

Plants often with a single main axis or several major branches from near base of plants. Herbage often yellowish canescent, or leaves with relatively sparse pubescence and green when young and vigorously grown; larger (usually lower) leaves with blades 5.5–8 cm long x 3–7 cm wide, the petioles to 3.7 cm long. Petals orange. Mericarps of *Sphaeralcea coulteri* and *S. orcuttii* seem indistinguishable (Felger 2000) except that *S. orcuttii* is reported to have larger mericarps; we found *S. orcuttii* mericarps only slightly larger: 1.7–2.6 (3.1) mm long (sometimes 2.1–3.0 mm long in the same capsule). Indehiscent part mostly very dark, some light colored and some in between — *S. orcuttii* seems to be more prone to have lighter colored mericarps than *S. coulteri*.

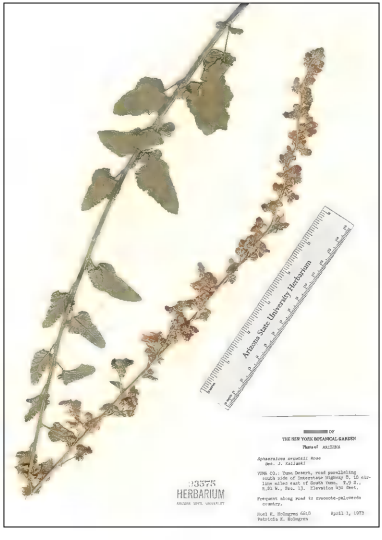

Figure 30. *Sphaeralcea orcuttii*. S side of Interstate 8, 16 air miles E of Yuma, Yuma Desert, Yuma Co., 1 Apr 1973, *Holmgren 6618* (ARIZ).

The morphological and ecological boundaries between *Sphaeralcea coulteri* and *S. orcuttii* seem continuous. *Sphaeralcea orcuttii* joins the ranks of other regional dune and blowing sand taxa and populations that may or may not warrant taxonomic recognition, especially where the sand-inhabiting plants differ primarily by relative gigantism, e.g., *Argythamnia serrata* sensu stricto, *Chamaesaracha felgeri*, *Croton wigginsii* sensu stricto, *Larrea tridentata* var. *arenaria*, *Palafoxia arida* var. *gigantea*, and *Stephanomeria schottii*.

Sphaeralcea coulteri has a dune form that approaches *S. orcuttii*, which seems best treated as an ecotype of *S. coulteri*. Stem pubescence may be a useful feature: *S. orcuttii* has a very short, dense almost velvety pelage. The leaf margin is not very toothed and almost crisped, the lower lobes are not very distinct, and the dried leaves are very brittle. The mericarps are very similar, but the notch is meant to be rather deeper in true *S. orcuttii*. Both species have the basal diploid chromosome number ($n = 5$), possibly facilitating gene flow.

CP: Near Tule Tank, 23 Mar 1935, *Kearney & Peebles 10900*. E edge of Pinta Sands, just E of Pinacate Lava Flow, abundant on gravelly–sandy–volcanic desert pavement, with *Malvella lepidota*, *Hymenoxys odorata*, 17 Apr 1983, *Hodgson H2077* (ASU, DES). Pinta Sands, low dunes, abundant, 1–1.3 m tall, 2 Feb 1992, *Felger 92-24*.

†Sphaeralcea sp./spp. (possibly, or possibly including *S. ambigua*)

OP: †Puerto Blanco Mts, on ridge, carpels, 3220 to 9860 (4 samples).

TA: †Butler Mts, twigs, leaf fragments, mericarps, 740 to 11,250 ybp (4 samples). Tinajas Altas, leaf fragments, mericarps, seed, 4010 to 10,950 ybp (10 samples).

MARTYNIACEAE – Devil's Claw Family

Annual and perennial herbs. Americas; 4 genera, 16 species.

Proboscidea – Devil's claw, unicorn-plant; *uña de gato*, *cuernitos*

Ephemerals or perennial herbs, glandular-sticky with mucilage-filled hairs, the surfaces slimy when fresh. Leaves opposite below, mostly alternate above, simple, with relatively long petioles; without stipules. Inflorescences of terminal racemes. Flowers bilateral, the corollas sympetalous and 2-lipped. Ovary superior with a basal nectar-producing disk. The green fruits develop a long, hooked beak. As the fruits mature and dry, the glandular-sticky green pericarp peels away from the woody capsule and the beak splits into 2 large claws. Americas; 8 species.

The unique, dry, woody capsules can be found at any time of year. The large claws may hook onto an animal's leg; dispersal agents probably include bighorn sheep, pronghorn, coyotes, and jackrabbits. Capsules multiple-seeded, the seeds sculptured.

1. Perennials with a large tuberous root; flowers yellow..... **Proboscidea altheifolia**
1. Ephemerals, the roots not tuberous; flowers pale lavender..... **Proboscidea parviflora**

Proboscidea altheifolia (Bentham) Decaisne

Desert devil's claw, desert unicorn-plant; *cuernitos, uña de gato*; ban 'ihugga. Figure 31.

Strongly scented herbaceous perennials from a deeply buried, large, thick, single tuberous root. The shoots emerging with warm weather in spring or about when the summer rains begin and withering with post-summer drought. Stems and petioles semi-succulent. Leaves often with petioles 4–11 cm long, the blades 2–6 cm long, broadly ovate, orbicular, or kidney-shaped and shallowly lobed. Flowers showy, often 4 cm long, the corollas bright yellow inside the tube and on lobes, with brown-purple speckles and dark yellow-orange nectar guides, the tube often bronze colored outside; flowering with hot weather. Capsule body 4–6.6 cm long, the claws 9–14 cm long. Seeds 6–9.2 mm long, obovoid, blackish, and warty.

Sandy to silty or clayish soils, mostly in washes, floodplains, and on creosotebush and saltbush plains; widely scattered across the flora area.

Southeastern California to western Texas, both states of Baja California, Sonora, and Sinaloa, and disjunct in Peru.

The large tuberous roots were peeled and the outer portion (cortex) eaten fresh by the Seris (Felger & Moser 1985). The seeds are edible, and the capsule fibers were used in basketry when *Proboscidea parviflora* was not available (Felger et al. 1992).

OP: 2 mi SE of Walls Well, 30 Aug 1945, *Gould 3217*. Quitobaquito, 25 Jul 1978, *Bowers 1387*. Puerto Blanco Drive 4 mi W of Hwy 85, 18 Sep 1988, *Wilson 198*.

CP: Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-675* (CAB). 1 mi E of Namer's Grave, 15 Sep 1992, *Felger 92-767*. Tule Tank, 2 Feb 1992, *Felger 92-66*.

TA: Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-18*.

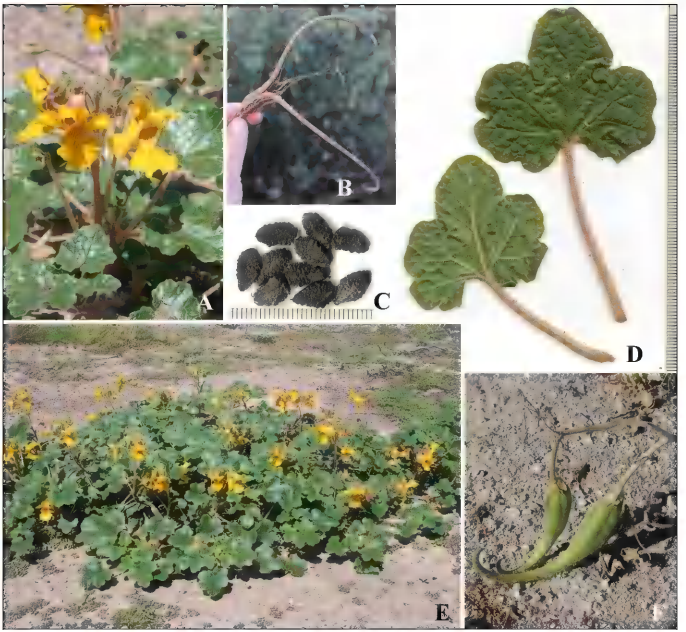

Figure 31. *Proboscidea altheifolia*. (A & E) Hwy 85 between Ajo and Why, 20 Aug 2006. (B) Ripe fruit, Kuakatch Wash near E boundary of Organ Pipe, 30 Jan 2014. (C) Seeds, Why, 20 Oct 2014. (D) Darby Arroyo near Hwy 85, 28 Jul 2014. (F) Unripe fruits, Hwy 85 near N boundary of Organ Pipe, 5 Oct 2013.

Proboscidea parviflora (Wooton) Wooton & Standley subsp. **parviflora**
Devil's claw; *cuernitos, uña de gato*; 'ihug. Figure 32.

Robust summer ephemerals, highly variable in size, sometimes reaching more than 1 m across with favorable conditions, usually much smaller; roots relatively small and poorly developed. Stems and petioles thick and semi-succulent. Larger leaves 12–30 cm long; petioles about as long as the blades, the blades broadly ovate and shallowly lobed. Flowers 3 cm long, the corollas pale lavender with purple blotches and white and yellow nectar guides. Capsule body 5–6 cm long, the claws 10–15+ cm long. Seeds 8 mm long, obovoid, blackish, and warty.

Figure 32. *Proboscidea parviflora* subsp. *parviflora*. Ajo: (A) 17 Sep 2008; (B & C) 2 Sep 2005. (D) Why, 6 Oct 2014.

Canyon bottoms, washes, and arroyos, often on silty-clayish soils and where water may temporarily accumulate; across much of Organ Pipe except the southwestern corner.

This subspecies occurs from southern Utah to central California, eastward to Trans-Pecos Texas and Chihuahua, and southward to northern and western Sonora. Southward in coastal Sonora and Sinaloa subsp. *parviflora* is replaced by subsp. *sinaloensis* (Van Eseltine) Bretting, and another subspecies occurs in Baja California Sur.

The seeds were casually eaten after the tough "husk" was peeled and discarded, and the young fruits were sometimes cooked and eaten. Wild plants have black seeds and shorter claws whereas plants of the domesticated cultivar have white seeds and much longer claws (Hodgson 2001;

Nabhan et al. 1981; Nabhan & Rea 1987; Rea 1997). The cultivar var. *hohokamiana* Bretting is grown by Native Americans in the southwestern USA. It is not known in the wild and has been selected for its much-elongated claws, white seeds, and reduced seed dormancy. Each claw yields a black strip used in basketry. It has been grown in O'odham gardens, likely at Quitobaquito and elsewhere. However, Betty Melvin said that "the Sand Papago didn't really use devil's claw" (Zepeda 1985: 61).

OP: Armenta Well, *Warren 16 Nov 1974*. Bull Pasture, *Wirt 13 Aug 1990*. Dos Lomitas, *Warren 17 Nov 1974*.

MOLLUGINACEAE – Carpetweed Family

Small ephemerals (in the Sonoran Desert Region). Leaves simple, entire. Flowers mostly small and inconspicuous, bisexual and radial. Ovary superior. Sepals 5; petals absent. Fruits of small capsules.

Worldwide, mostly tropics and subtropics; 14 genera, 125 species.

1. Plants pubescent with star-shaped hairs..... **Glinus**
1. Plants glabrous..... **Mollugo**

Glinus

Mostly tropics and subtropics. Worldwide, 6 species.

***Glinus radiatus** (Ruiz & Pavón) Rohrbach
Shining damascisa. Figure 33.

Figure 33. *Glinus radiatus*. Salero Ranch, Santa Cruz Co.: (A & C) 26 May 2013; (B & D) 2 Jul 2014. Photos by Sue Carnahan.

Small ephemerals, apparently non-seasonal; densely gray-pubescent with stellate hairs, the young plants erect to spreading, the older plants prostrate and developing a relatively deep tap root. Leaves whorled, petioled, the blades 5–25 mm long, obovate to orbicular or broadly spatulate. Flowers inconspicuous in axillary clusters, 4 mm long, white and green. Fruits of small capsules with many seeds.

Seasonally and locally abundant in drying mud of dirt charcos in Cabeza Prieta and sometimes in drying mud holes along washes. These are the only records for this species in Arizona.

Native to tropical and subtropical areas in the Americas and naturalized from southern California to Texas.

CP: Cabeza Prieta, in a wash, 8 Oct 1977, *Phelps 12* (ASU, det. Tim Reeves 1980). Jose Juan Tank, 12 Jun 1992, *Felger 92-565*. Redtail Tank, 12 Jun 1992, *Felger 92-552*.

Mollugo

Annuals, herbaceous perennials, and shrubs. Nearly worldwide, 35 species.

***Mollugo cerviana** (Linnaeus) Séringe

Thread-stem carpetweed, Indian chickweed. Figure 34.

Diminutive summer-fall ephemerals; glabrous. Stems thread-like, 4–13.5 cm long, ascending to spreading, often orange. Leaves somewhat glaucous; first leaves in a basal rosette (an unusual feature among hot-weather ephemerals), 3.5–11 × 1–2 mm, linear-spatulate to spatulate; stem leaves whorled, 6–14.5 × 0.3–1.1 mm, linear to linear-spatulate; stipules none. Flowers on thread-like axillary pedicels. Sepals 5, separate, and persistent, 1.2–1.7 mm long, thin, green especially along veins and with white membranous margins. Stamens 5. Capsules globose, 1.2–1.5 mm wide, multiple-seeded. Seeds 0.33–0.42 mm wide, snail-shaped, minutely reticulate with faint striae (low, thin lines) on the dorsal side, uniformly red-brown.

Figure 34. *Mollugo cerviana*. Dunes about 25 mi SW of Sonoyta on Mex Hwy 8, 12 Sep 2014.

Sandy soils of desert flats, washes and floodplains, perhaps sometimes on rocky soils, in the southwestern part of Organ Pipe and westward in Cabeza Prieta, and Coyote Wash in the Lechuguilla Valley.

Widespread in the Sonoran Desert and elsewhere in southwestern North America and Mexico as well as warm regions worldwide; reported as native to the Old World.

OP: Aguajita Wash, 14 Sep 1988, *Felger 88-419*. Senita Basin, 2640 ft, *Wirt 28 Jul 1990*.
CP: Jose Juan Tank, sand flats near the charco, 14 Sep 1992, *Felger 92-715*.
TA: Coyote Water, 25 Oct 2004, *Felger 04-50*.

MONTIACEAE — Miner's Lettuce Family

Annual and perennial succulent and semi-succulent herbs. Flowers radial. Fruits of capsules. These plants classically have been included in the Portulaca Family (Portulacaceae) and more recently placed in the miner's lettuce family.

Nearly worldwide; 22 genera, 230 species.

1. Summer-fall perennials growing with warm weather; first leaves not in a basal rosette; flowers yellow-orange, solitary in leaf axils..... **Phemeranthus**
1. Winter-spring ephemerals, the lower (first) leaves in a basal rosette; flowers not yellow-orange.

2. Lower leaves with conspicuous petioles, the petioles and blades distinct; leaves below (subtending) the inflorescence sessile and disk-shaped (these perfoliate, formed of fused opposite leaves surrounding the stem)..... **Claytonia**
2. Leaves with indistinct petioles; leaves beneath flowers reduced and not disk-shaped.

3. Petals 5; capsules 3-valved, ovate to globose..... **Calandrinia**
3. Petals 3; capsules 2-valved, oblong or cylindrical..... **Calyptridium**

Calandrinia

Annual to herbaceous perennials, succulent; western Americas, 14 species.

Calandrinia menziesii (Hooker) Torrey & A. Gray
[*Claytonia ciliata* var. *menziesii* (Hooker) J.F. Macbride]
Fringed redmaids. Figure 35.

Succulent winter-spring ephemerals. Stems to 20 cm long, ascending, spreading, or prostrate. Leaves alternate, to about 10 cm long, sessile, linear to oblanceolate, glabrous or ciliate, in basal rosettes and alternate on flowering stems. Inflorescences of racemes with leaf-like bracts and the flowers 2–15 on one side of the branch. Flowers on pedicels 4–13 mm long; sepals 2, scarious, 2.5–8 mm long; petals 5, 4–11 mm long, pink-purple. Capsules with 3 valves opening longitudinally from the tip, and multiple-seeded.

Ajo Mountains and locally in the Puerto Blanco Mountains. The plants were eaten as greens in spring (Hodgson 2001).

Eastward in southern and central Arizona; British Columbia to South America.

The North American plants were formerly known as *Calandrinia ciliata* (Ruiz & Pavón) de Candolle, a species occurring in South America (Hershkovitz 2006).

OP: Alamo Canyon, 1 Apr 1944, *Clark 11555* (ORPI). Near Jackson's Hole, N-central Puerto Blanco Mts, *Rutman 4 Mar 1998* (ORPI). Armenta Road 1.4 mi W of Hwy 85, 11 Mar 2003, *Felger 03-264*. Bull Pasture, 10 Apr 2005, *Felger 05-206*.

Figure 35. *Calandrinia menziesii*. (A & B) Bull Pasture Trail, just below Bull Pasture, 28 Feb 2009. (C) Alamo Canyon, 26 Feb 2014.

Calyptridium – Pussypaws

Annual and perennial herbs. Americas; 9 species.

Calyptridium monandrum Nuttall

[*Cistanthe monandra* (Nuttall) Hershkovitz]

Sand-cress. Figure 36.

Winter-spring ephemerals; plants often reddish, the stems to 15 cm long, spreading to ascending. Early leaves in a basal rosette, well-developed and withering by flowering time, to 7.5 cm long, spatulate and entire; stem leaves alternate and reduced. Inflorescences of 1-sided racemes, with ovate to elliptic bracts. Flowers sessile, sepals 2, fleshy, scarious-margined in fruit, 1–3 mm long; petals 3, white to pinkish or reddish, 1–3 mm long; stamens 1; stigmas 2 and sessile. Capsules with 2 valves, ovoid to cylindrical, 2.5–8 mm long, with 1–10, smooth, black, and shiny seeds.

Canyons and washes in the northern part of Organ Pipe and the Ajo Mountains, often abundant at higher elevations in the Ajo Mountains.

Southern and central Arizona, California, Nevada, Baja California, and northern Sonora; largely in non-desert habitats.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Estes Canyon, 11 Apr 1978, *Bowers 1237* (ORPI). S of Armenta Ranch road, 27 Feb 2003, *Rutman 2003-197* (ORPI). Kuakatch Wash near E boundary, 2 Mar 2003, *Rutman 2003-214* (ORPI).

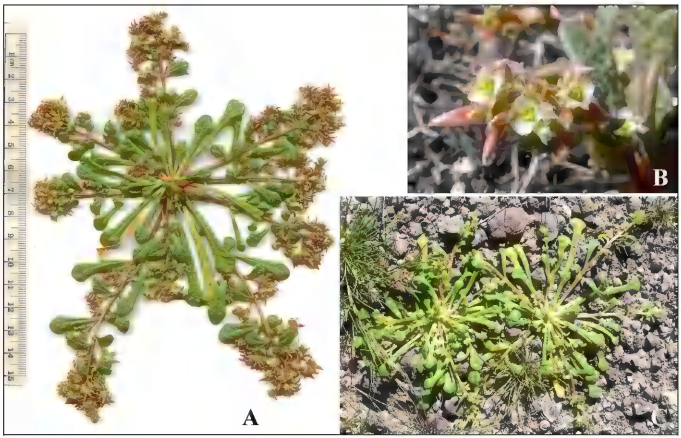

Figure 36. *Calyptridium monandrum*. (A) Kuakatch Wash near E boundary of Organ Pipe, 11 Mar 2015. (B) Anza Borrego State Park, San Diego Co., 20 Apr 2013, photo by Keir Morse (CalPhotos). (C) Chuckwalla Hills, 6 Feb 2005.

Claytonia

Annual to perennial herbs. North and Central America, and Asia; 27 species.

Claytonia perfoliata Donn ex Willdenow subsp. **mexicana** (Rydberg) J.M. Miller & K.L. Chambers [*Montia perfoliata* (Donn ex Willdenow) Howell]
Miner's lettuce. Figure 37.

Semi-succulent glabrous winter-spring ephemerals to 25 cm tall. Leaves basal, often 2–10+ cm long, highly variable, ovate to oblanceolate or obdeltate; flowering stems slender with 2 fused (perfoliate, connate) disk-like leaves just below the inflorescences. Flowers in small clusters above the connate leaves; sepals 2, 1.5–4 mm long; petals 5, white, 1–3 mm long. Stamens 5. Capsules 3-valved, 1.5–4 mm long, the margins rolling inward and forcibly expelling the seeds when fully ripe. Seeds lens-shaped, brown or black and shiny. As the common name implies, the plants are edible and can refresh a backpacked sandwich.

Ajo Mountains in canyon bottoms and on slopes into the oak zones, especially in moist and partially shaded habitats.

Eastward in southern and central Arizona. This species occurs in British Columbia and western USA to Central America. Subsp. *mexicana* ranges from California to New Mexico and southward to Guatemala; the three subspecies are difficult to identify and their practical significance has been questioned (Howe 2006; Miller & Chambers 2012).

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Pitahaya Canyon, 25 Mar 1990, *Baker 7783* (ORPI). The Cones, on trail to Mount Ajo, 3565 ft, 10 Apr 2005, *Felger 05-243*.

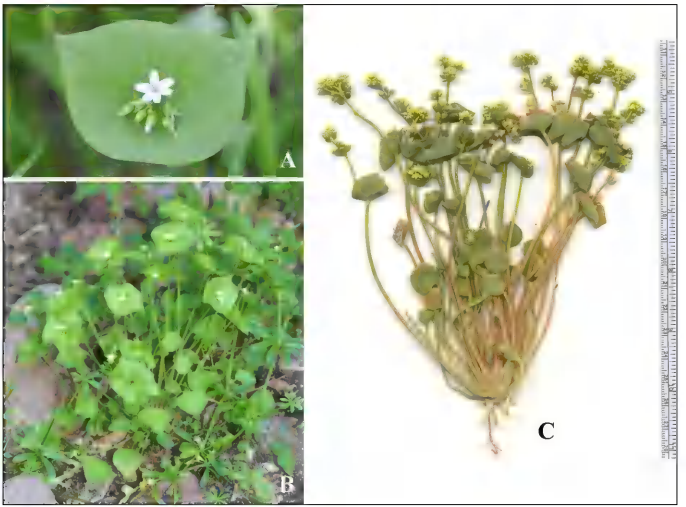

Figure 37. *Claytonia perfoliata* subsp. *mexicana*. Alamo Canyon: (A) 28 Feb 2009; (B) 24 Mar 2008; (C) 12 Mar 2005.

Phemeranthus

Perennial, succulent herbs. Americas; 25–30 species

Phemeranthus aurantiacus (Engelmann) Kiger
[*Talinum aurantiacum* Engelmann. *T. aurantiacum* var. *angustissimum* A. Gray]
Orange flame-flower. Figure 38.

Herbaceous perennial succulents, glabrous, and with tuberous roots; growing during the summer rainy season, dying back to the rootstock after the rains cease. Stems leafy, to 50 cm long. Leaves succulent, alternate, to 6 cm long, mostly narrowly linear but robust new growth may bear broader leaves with 1–few broad, shallow lobes. Flowers 1–3 in leaf axils; sepals 2, ovate, 5–10 mm long and deciduous; petals obovate, 9–15 (20+) mm long, bright yellow to orange; stamens many. Flowers opening for 2–4 hours in the afternoon to early evening of one day, sometimes facultatively cleistogamous. Capsules 3-valved, 4–7 mm long, ovoid to globose, and many-seeded.

Ajo Mountains at least in Alamo and Arch canyons and Bull Pasture, often in shallow soils with *Selaginella arizonica*.

Eastward in southern Arizona, mostly at elevations above the desert; to western Texas, Sonora, and Chihuahua and to Nuevo León and San Luis Potosí.

OP: Bull Pasture, 3300 ft, 9 Aug 1979, *Bowers 1798*.

Figure 38. *Phemeranthus aurantiacus*. (A & C) Bull Pasture, 24 Sep 2006. (B) Salero Ranch, Santa Cruz Co., 31 Jul 2013, photo by Sue Carnahan. (D) Trail to Mt. Ajo, above Bull Pasture, 24 Sep 2006.

MORACEAE – Mulberry Family

Herbs, but mostly shrubs, vines, and trees. Worldwide; 39 genera, 1125 species.

****Ficus*** – Fig

Trees, shrubs, and vines. Worldwide, mostly tropical; 750 species.

****Ficus carica*** Linnaeus

Fig; *higuera*; su:na. Figure 39.

Large shrubs or small trees. At the end of the 20th century the remnant of a small orchard of mission figs and pomegranates persisted at Quitobaquito along old irrigation ditches below the pond, although many of the trees had perished. By 2010 the last figs finally succumbed, probably due to a combination of lack of water and perhaps age. These trees are said to have been cultivated by the O'odham from Spanish introductions, although Hoy (1970: 48) reported that "Andrew" [Arnold] Dorsey planted fig trees ca. 1860. Hia-Ced O'odham "people would travel to Quitobaquito and harvest the figs. . . and turn the figs into *jun* or jam" (Miguel Velasco in Zepeda 1985: 23, 65).

OP: Quitobaquito: Surviving in a row below the pond along abandoned irrigation ditches, planted here many years ago, seems to be "mission fig" variety, water-stressed, stunted shrubs 2.5 m tall (some much smaller due to extensive die-back), 23 Jul 1986, *Felger 86-221*; Small grove below pond, shrubs to 2 m, barely surviving, 19 Jun 1989, *Felger 89-243*.

Figure 39. *Ficus carica*. Arrows point to *Ficus* plants along irrigation canals west of Quitobaquito Pond, 1940s, photo by William (Bill) Supernaugh (Organ Pipe Cactus National Monument, black and white photo collection, accession #422).

Morus – Mulberry

Trees and shrubs. North America and Eurasia; 10 species.

Morus microphylla Buckley

Littleleaf mulberry; *mora cimarrona*; gohi. Figure 40.

Woody shrubs to at least 3 m tall. Leaves alternate, mostly winter deciduous, highly variable depending on soil moisture and position on the tree, often 3–8 (10+) cm long including petioles 0.9–2 cm long, the leaf blades broadly ovate, sometimes deeply 3-lobed especially on vigorous new growth, rough (scabrous) on both surfaces; leaf margins serrate-toothed (young, developing leaves with gland-tipped teeth); stipules paired, membranous, unequal in size, and quickly deciduous. Male and female flowers on separate plants, in catkins and wind pollinated, mostly flowering with new growth in spring. Male catkins white, the flowers 5–6 mm wide, with membranous sepals. Stamens 4, longer than the sepals, the filaments flattened; developing stamens inflexed (incurved), held by the cupped sepal-bases, at maturity elastically and suddenly bending outward like a tension-held spring to fling dry pollen in a puff. Female catkins often 1–1.5 cm long; flowers 2.5–3 mm wide, the sepals about as long as the ovary, green with fringed margins. Stigmas thick, 2-branched, yellow-green, and sessile or nearly so. Fruits syncarpous (multiple or aggregate fruits), ± 1 cm long, red or blackish red at maturity, fleshy and tasty but too small to be more than trail snacks.

Ajo Mountains at least in Alamo and Boulder canyons.

Eastward to southeastern and central Arizona, New Mexico, Texas, and Oklahoma, and southward to Durango, Chihuahua, and Sonora.

OP: Alamo Canyon, *Nichol 4 May 1939*. Boulder Canyon, 3000 ft, tree to 12 ft, rare in the Ajo Mts, 3 May 1978, *Bowers 1291*.

Figure 40. *Morus microphylla*. (A) Texas Canyon, Organ Mts, Doña Ana Co., NM, 15 May 2010, photo by Patrick Alexander (SEINet). (B) Male flowers, Tejano Spring, Salero Ranch, Santa Cruz Co., 20 Mar 2014, photo by Sue Carnahan.

ACKNOWLEDGEMENTS

In addition to the gratitudes provided in part 1 in this flora series we thank Susan Davis Carnahan (ARIZ) for copyediting expertise. Additional important information, review, or assistance was provided by Sue Carnahan, Walter Frank Fertig (ASU), George McNeil Ferguson (ARIZ), C. Matt Guilliams (Santa Barbara Botanic Garden), Richard (Rick) Allan Johnson (Silver City, New Mexico), and James (Jim) Thomas Verrier (ARIZ). We acknowledge Lisa Höfler and David Fleming for their assistance in producing images using a Visionary Digital Passport II system, which was facilitated by the ASU Hasbrouck Insect Collection, as well as assistance in the ASU Herbarium by Elizabeth Makings and Les Landrum. For the use of photographs we thank Patrick Alexander, Sue Carnahan, Jillian Cowles, Henry (Hank) Jorgenson, Keir Morse, and David C. Thornburg.

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VARIANTS OF *ERIGERON DIVERGENS* (ASTERACEAE)

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ABSTRACT

A distinctive variant previously identified as *Erigeron divergens* is recognized here as *Erigeron incomptus* A. Gray (synonym = *E. accedens* Greene) — it occurs widely in Arizona and into adjacent southwestern Utah, southwestern New Mexico and El Paso Co., Texas, and at least in northern Sonora and Chihuahua, Mexico. Apparently disjunct outliers occur in north-central California and northwestern Baja California. Plants of *E. incomptus* are perennial (flowering in the first year but eventually producing a woody caudex) with pinnatifid basal and lower cauline leaves with long petioles persisting after the blades are gone. *Erigeron incomptus* over its whole range is sympatric with typical, more widely distributed *E. divergens*, which is annual in duration and without the long-petioled, pinnatifid proximal leaves. Among annual plants of *E. divergens*, two variants are informally recognized: (1) those mostly single-stemmed from the base (typical *E. divergens*) and (2) those consistently with multiple stems from the base, all arising compactly from a caudex-like taproot apex. Chromosome counts of *E. incomptus* are triploid ($2n = 27$) and tetraploid ($2n = 36$); annual forms of *E. divergens* are reported as diploid, triploid, and tetraploid. Photos of specimens are provided as examples of the morphology of each of the three variant forms of *E. divergens* sensu lato, emphasizing variability in *E. incomptus*.

Erigeron divergens has long been viewed and treated as a polymorphic entity comprising morphological variants and a mixture of diploid and polyploid populations (e.g., Cronquist 1947; Nesom 2006 in FNANM). It occurs widely over the western USA and northwestern Mexico. A putative variant of *E. divergens* with prostrate, flagelliform runners, which Cronquist treated as *E. divergens* var. *cinereus* A. Gray, is segregated in the FNANM treatment as *E. tracyi* Greene (synonyms *E. colomexicanus* A. Nels., *E. dicladus* Greene; the name *E. mudiflorus* Buckl. has been misapplied to the species). Hybrids occur between *E. divergens* and *E. tracyi*, *E. flagellaris* A. Gray, and *E. modestus* A. Gray (*E. commixtus* Greene perhaps is a divergens-tracyi hybrid) but each of the species is in general morphologically distinctive. Whether hybrids occur among the three forms of *E. divergens* discussed below is not known.

Polyploidy and agamospermy apparently are common in *Erigeron divergens* and its close relatives and, along with hybridization, probably underlie the variability and apparent polymorphism characteristic, at least in part, of these species and hybrids. Diploids appear to be scattered through the range of *E. divergens*, at least in its southern part (reports in many references).

Three major morphological variants within *Erigeron divergens* sensu lato are found in its range in the southwestern USA. In the rest of the range (mostly northward), only the annual forms occur.

1. Annual plants essentially single-stemmed from the base (*Erigeron divergens* sensu stricto), with branches arising laterally from various points above the base but only uncommonly from near the very base (Figs. 1–3). This form occurs from Mexico north into western Canada.

Erigeron divergens Torr. & A. Gray, Fl. N. Amer. 2: 175. 1841. Based on *Erigeron divaricatus* Nutt., Trans. Amer. Philos. Soc. 2, 7: 311. 1840 [not *E. divaricatus* Michx. 1803]. **TYPE: USA.** Protologue: "Rocky Mountains, and plains of the interior of Oregon, Nuttall!" No

other data, *T. Nuttall 175* (holotype or lectotype: BM?; isotype: GH 6674, lower right plant, GH 6675 right plant).

Erigeron gracillimus Greene, Leafl. Bot. Observ. Crit. 2: 212. 1912. **TYPE: USA. Arizona.** [Coconino Co.]: Protologue: "Common on stony slopes, in forest of yellow pine, in the Coconino Forest Reservation, northern Arizona, the specimens collected 24 August 1911, by Jardine & Hill, who give 6800 feet as the altitude of the woodlands where it grows. On U.S. Herb. sheet 326788 are four good specimens of the same, distributed from the same general region, collected by M.E. Jones, 17 Sept. 1894. The special locality given for these is Nagle's Ranch." The description notes "Root annual, stem strictly erect, simple to near the summit." No syntypes found in available databases; not at NDG.

Erigeron furcatus Greene, Leafl. Bot. Observ. Crit. 2: 213. 1912. **TYPE: USA. Arizona.** Coconino Co.: San Francisco Mts, Kendrick's Park, 20 Aug 1889, *F.H. Knowlton 43* (holotype: US digital image!). Not at NDG.

Erigeron solisaltator Nesom, Madroño 28: 145. 1981. **TYPE: MEXICO. Chihuahua.** 0.5 km S of Rancho El Llano, flat (bottom of bolson), zacatal, 1185 m, 14 Jun 1973, *M.C. Johnston, T. Wendt, & F. Chiang 11317F* (holotype: TEX! digital image!).

2. Annual plants (sometimes short-lived perennial) with multiple stems from the base, all usually arising compactly from a caudex-like taproot apex, sometimes (in early season plants) bowl-shaped with decumbent-ascending stems and solitary heads topping unbranched stems (Fig. 4). Basal and lower cauline leaves are spatulate, the blades with entire or shallowly toothed margins. Plants of this form have a tendency to develop strongly woody taproots and a caudex with separated meristematic apices and in these respects are similar to *E. incomptus*, with which they may hybridize (Figs. 5, 6). The annual, "multicipital caudex" form occurs in northwestern Mexico into southwestern Texas, New Mexico, Arizona, and California. It is conceivable that the perennial *E. multiceps* Greene, which has this growth form, is a direct derivative of annual *E. divergens* (see comments in Nesom 2006).

Erigeron divergens (multi-stemmed from the base)

Erigeron deustus Greene, Leafl. Bot. Observ. Crit. 1: 211. 1906. **TYPE: USA. New Mexico.** [Catron Co.]: Mogollon Mts, West Fork of Rio Gila, ca. 7500 ft, 28 Aug 1903, *O.B. Metcalfe s.n.* (holotype: NDG digital image!).

Erigeron tephrodes Greene, Leafl. Bot. Observ. Crit. 1: 222. 1906. **TYPE: USA. California.** Inyo Co.: Foothills west of Bishop [protologue: "in moist grassy places near the house in "McGee's meadows"], 23 May 1906, *A.A. Heller 8315* (holotype:?; isotypes: CAS, F, GH, MO NY, P, PH, RENO, US-129072 and 129073). Digital images! of all types. No specimen at NDG. None of the collections cited here have the protologue locality details noted by Greene; a lectotype might be designated, but it seems likely that a specimen exists with these details.

Erigeron wootonii Rydb., Bull. Torrey Club 33: 153. 1906. Based on *Erigeron cinereus* var. γ A. Gray, Mem. Amer. Acad. Arts n.s. 4: 68. 1849. **TYPE: USA. New Mexico.** [Santa Fe Co.]: Protologue: "From the valley of Santa Fe Creek, near irrigating ditches; May to July. (385)." Label: 1847, *A. Fendler 385* (holotype: GH 6655 digital image!; isotype: GH 6656 digital image!).

Erigeron lavandulaceus Greene, Leafl. Bot. Observ. Crit. 2: 214. 1912. **TYPE: USA. Nevada.** [Douglas Co.]: Gardenville, 15 Jun 1902, *C.F. Baker 1085* (holotype: NDG digital image!; isotypes: CAS, GH, RM, RSA, US). Digital images! of all types.

3. Perennial plants (flowering in the first year from a slender taproot but eventually producing a woody taproot and woody, branching caudex) with pinnatifid basal and lower cauline leaves with long petioles persistent after the blades are gone (Figs. 7–19, Figs. 7–14 showing increasing development of a woody caudex). The pinnatifid leaves usually are crowded along 1–4(–8) cm of the stem base. Such plants, which I have annotated at various times and referred to (e.g., Nesom 2006) as the "*Erigeron accedens* form" of *E. divergens*, occur widely in Arizona and into adjacent

southwestern Utah, southwestern New Mexico and El Paso Co., Texas, and at least in northern Sonora and Chihuahua, Mexico. Apparently disjunct outliers occur in north-central California and northwestern Baja California (Map 1, Mexican localities other than Baja California not shown). The earliest name for the perennial form of *Erigeron divergens* is *E. incomptus* A. Gray.

In Arizona, *Erigeron incomptus* occurs at (1350–)2000–5000(–rarely to 6500) feet and flowers March–June, continuing sparsely into August and very rarely to October and November. Elsewhere it has been documented in flower as early as February and at elevations as low as 600 feet.

Erigeron incomptus occurs sympatrically with annual forms. Most chromosome counts of *E. incomptus* have been triploid, and apomictic seed production associated with triploidy in *Erigeron* probably contribute to its apparent morphological stability. Vouchers for triploid counts are shown in Figs. 16–19; a voucher for a tetraploid count is cited below from Doña Ana Co., New Mexico. The coherent geographical distribution in Arizona suggests that at least the triploids of *E. incomptus* had a single origin.

It seems likely that *E. incomptus* is of hybrid origin, the parental combination speculative. Whether the California and Baja California plants are long-distance disjuncts or of independent origin is not clear — typical *E. divergens* occurs in both areas but both areas are outside of the range of *E. flagellaris* and *E. tracyi*, which presumably are the closest relatives of *E. divergens* and among potential parents (if *E. incomptus* is a hybrid). Basal leaves in California and Baja California populations are unlobed but otherwise similar in morphology and placement to those eastward.

Plants apparently intermediate between *Erigeron incomptus* and annual forms are shown in Figs. 5–6. If they indeed are genetic intermediates, it suggests that tetraploid *E. incomptus* (capable of crossing with typical *E. divergens*) probably is more common than indicated by the limited sampling of chromosome numbers. Otherwise, it is possible that such plants are triploid *E. incomptus* showing further variation in the range of its expression.

The epithet *incomptus* (Latin, unadorned) alludes to the ray floret ligules much reduced in size (as in the type collection) — similar floral variants are known from other *Erigeron* species, including *E. flagellaris*.

Erigeron incomptus A. Gray, Synopt. Fl. N. Amer. 1(2): 218. 1884. *Erigeron divergens* forma *incomptus* (A. Gray) Cronq., Brittonia 6: 261. 1947. **Type: MEXICO. Baja California.** Carysito, 29 May 1883, *C.R. Orcutt 874* (holotype: GH digital image!; isotypes: NY digital image!, UC digital image!; possible isotypes: P-2 sheets digital images!).

The P specimens have as collection data only "Orcutt, 1883, Lower California," but they are closely similar to those at GH and NY and plausibly from the same collection.

Erigeron cinereus var. ß A. Gray, Mem. Amer. Acad. Arts n.s. 4: 68. 1849. **TYPE: USA. New Mexico.** [Santa Fe Co.]: Protologue: "Low, sandy banks of the Rio del Norte and of Santa Fe Creek; May to June. (380)." Label: 1847, *A. Fendler 380* (GH 6655, plant on right side of sheet). While "var. ß" is not a name, it seems useful to associate a specimen with the plant referred to by Gray.

Erigeron californicus Jeps., Bull. Torrey Club 18: 324. 1891. **TYPE: USA. California.** Sutter Co.: Marysville Buttes region, summit of South Peak, 20 Apr 1891, *W.L. Jepson s.n.* (holotype: JEPS 2569 digital image!; isotype: JEPS 2570 digital image!).

Erigeron cinereus var. *aridus* Jones, Proc. Calif. Acad. Sci. 2, 5: 695. 1895. **TYPE: USA. Utah.** [Washington Co.]: Protologue: "Washington, on sandstone rocks." Label: Silver Reef, gravel, 3500 ft, 3 May 1894, *M.E. Jones 5149v* (holotype: POM-RSA0001125 digital image!; isotype: US digital image!).

Erigeron accedens Greene, Pittonia 4: 155. 1900. **TYPE: USA. Arizona.** [Greenlee Co.]: Clifton, Apr 1899, *A. Davidson s.n.* (holotype: NDG! digital image!).

The *Erigeron* collections at ASU have been curated to reflect the distinction of *E. incomptus* from other expressions of the species. These records from Arizona can be found via SEINET (2015). Collections examined documenting the occurrence of *E. incomptus* in California, Utah, New Mexico, and Texas is provided here. From Baja California, I have seen only the type collection of *E. incomptus*.

California. Butte Co.: Berry Canyon (near Clear Creek), 6 May 1902, *Heller & Brown s.n.* (MO). Sutter Co.: Marysville Buttes, 17 May 1903, *Copeland 3234* (MO); Marysville Buttes, 22 Mar 1905, *Heller 7579* (MO); steep rocky slopes on S side of Marysville Buttes, in the *Quercus douglasii* belt, 15-16 Aug 1927, *Heller 14341* (MO-2 sheets). The type of *Erigeron californicus* is from Sutter County.

New Mexico. Doña Ana Co.: 1/2 mi W of Organ, S side of US-70, common in arroyo, 5000 ft, 16 May 1981, *Ward & Spellenberg 81-020* [voucher for *n* = 18] (TEX); Potrillo Mts, Mt Riley SE side, rocky slope, 23 Mar 1995, *Worthington 24206* (TEX); Potrillo Mts, W Potrillo Mts, road between El Paso and Columbus, 25 Mar 1955, *Worthington 24219* (TEX). Hidalgo Co.: 9 air mi SSW of Lordsburg, Pyramid Mts, W slope of Leitendorf Hills, rocky slope, 8 Apr 1984, *Worthington 11750* (TEX). Luna Co.: ca 9 mi WSW of Deming, S side of Red Mt, canyon and rocky slopes, 5200 ft, 13 Apr 1985, *Worthington 12990* (TEX).

Texas. El Paso Co.: Franklin Mts., 0.9 mi. W of jct Trans-Mountain Rd and Gateway South, 4300 ft, below road in arroyo, rhyolite alluvium, 28 May 1978, *Worthington 2881* (TEX); El Paso, NE part of city in yard of house at 10937 Whitey Ford, yard landscaped with crushed marble, 4 Sep 2010, *Worthington s.n.* (TEX).

Utah. Washington Co.: 5.2 mi NW of Toquerville, Browse Road on E flank of Beatty Hill, ca. 0.6 mi NW of Interstate 15, flats of volcanic rubble over brown clay soil, *Quercus turbinella* scrub community, burned in 2005, 4310 ft, 12 May 2012, *Fertig 27377* (UTC digital image!). Also see the type of *Erigeron cinereus* var. *aridus*, which is from Silver Reef in Washington County.

ACKNOWLEDGEMENTS

I am grateful to the staffs of TEX-LL, SMU/BRIT, and ASU — especially Walter Fertig at ASU for providing the photos of ASU specimens and for updating the ASU database (see SEINET) to reflect the new identifications of *Erigeron incomptus* (annotated at ASU as *E. accedens*, before associating the earlier name with these plants), to Barbara Hellenthal for checking the type status of specimens in the E.L. Greene herbarium at Notre Dame, and to John Strother for comments on the manuscript.

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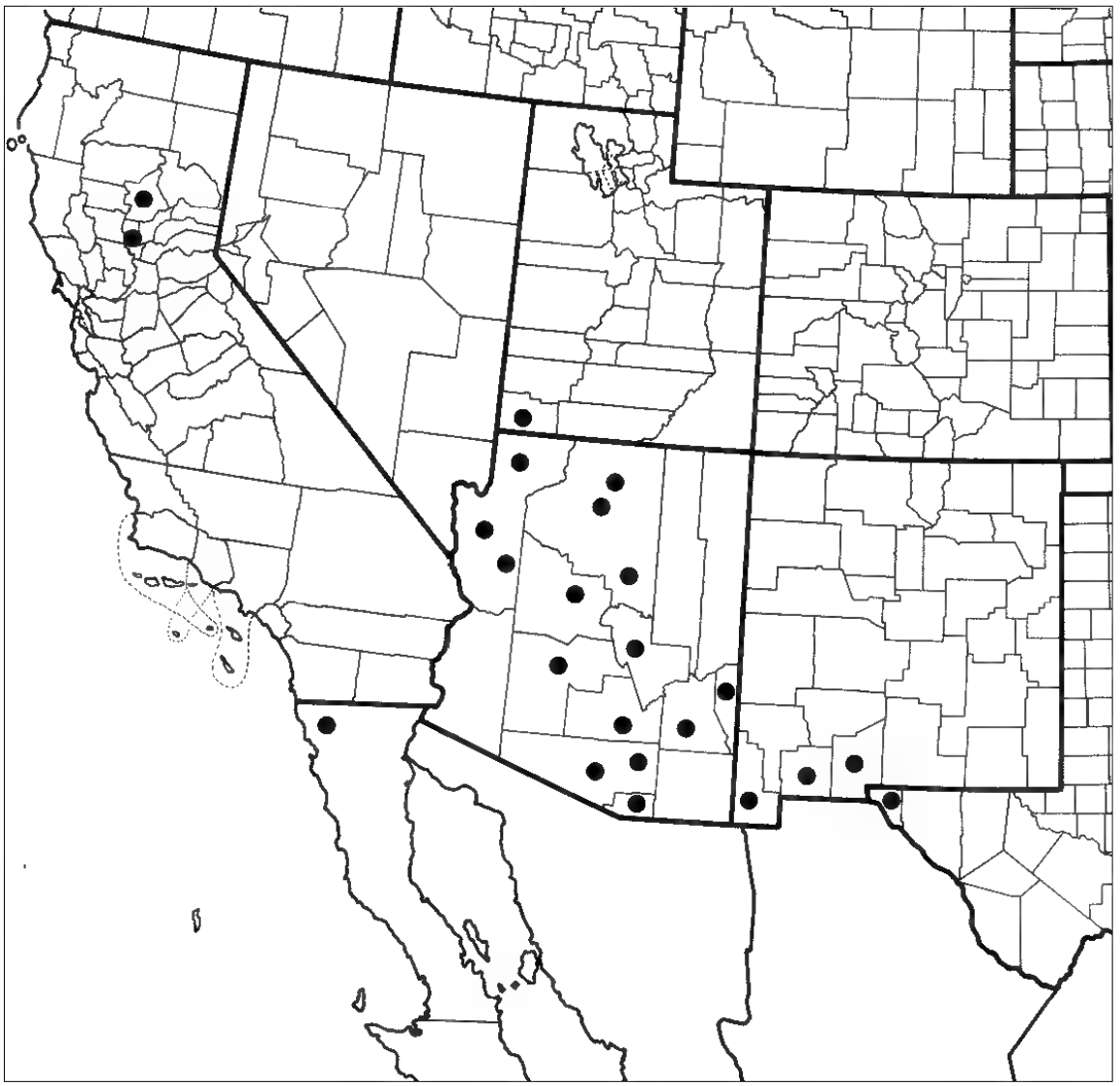

Map 1. Distribution of *Erigeron incomptus* in the USA and Baja California, Mexico. It presumably should be expected to occur in southeastern Nevada. The range continues southward at least into Sonora and Chihuahua, Mexico.

Figure 1. *Erigeron divergens*, Yuma Co., Arizona, single-stemmed from the base.

Figure 2. *Erigeron divergens*, Yuma Co., Arizona, single-stemmed from the base.

Figure 3. *Erigeron divergens*, Greenlee Co., Arizona, single-stemmed from the base.

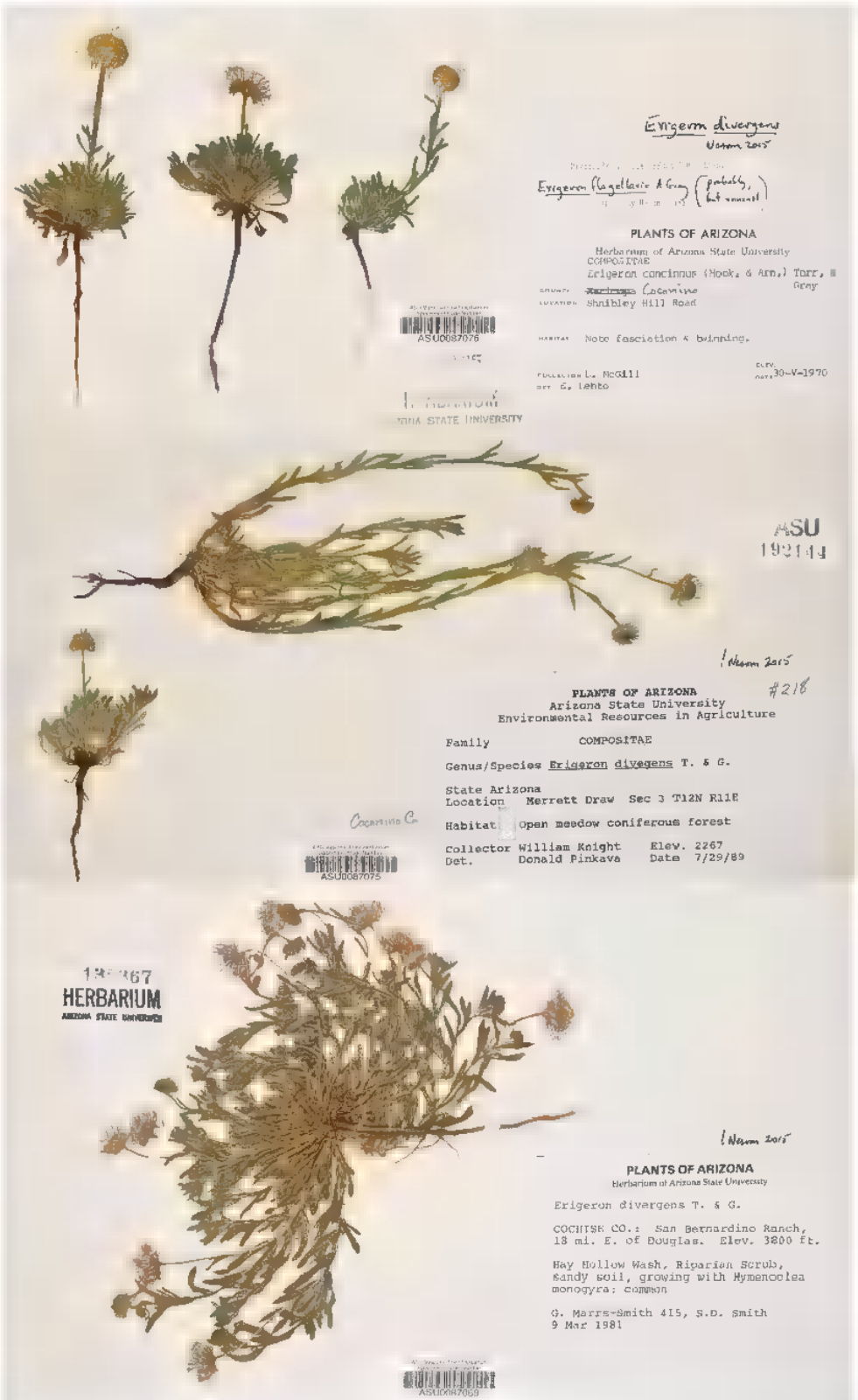

Figure 4. *Erigeron divergens*, Coconino and Cochise cos., multi-stemmed from the base.

Figure 5. *Erigeron incomptus* > *divergens*, Pinal Co., Arizona, multi-stemmed from the base, with woody, multicipital caudex similar to that of *E. incomptus*. Lower leaves entire with tendency for long, narrow petioles.

Figure 6. *Erigeron incomptus* > *divergens*, Santa Cruz Co., multi-stemmed from the base, with woody, multicipital caudex similar to that of *E. incomptus*. Lower leaves entire with tendency for long, narrow petioles.

Specimen entered in ASU Database
ASU
256902
cm
0 1 2 3 4 5 6 7 8 9 10
copyright reserved
ASU
Erigeron accedens
Nesom 2015
Erigeron divergens Torr. & A. Gray
Det. from duplicate Guy Nesom, 2002
Botanical Research Institute of Texas (BRIT)
Plants of Arizona
Flora of Seven Springs
ARIZONA STATE UNIVERSITY
Erigeron divergens Torr. & Gray
Family: Asteraceae
Arizona, Maricopa Co.; Tonto National Forest.
Between Seven Springs road and Camp Creek, near pull-off
stop just south of FS road 1509, ■ 33° 54.943', W 111° 48.944'
Habitat: Chaparral. Elevation: 3400 ft. (1037 m)
Associated spp: Quercus turbinella, Juniperus coahuilensis,
Yucca baccata, Ferocactus cylindraceus, Acacia greggii,
Prosopis velutina.
Notes: Annual herb with purple rays.
Collected by: Shannon Doan 621 17 April 2001
with: D.Z. Damrel, A. Salywon
ASU0087057

Figure 7. *Erigeron incomptus*, Maricopa Co., Arizona.

Figure 8. *Erigeron incomptus*, Pima Co., Arizona.

Figure 9. *Erigeron incomptus*, Pima Co., Arizona.

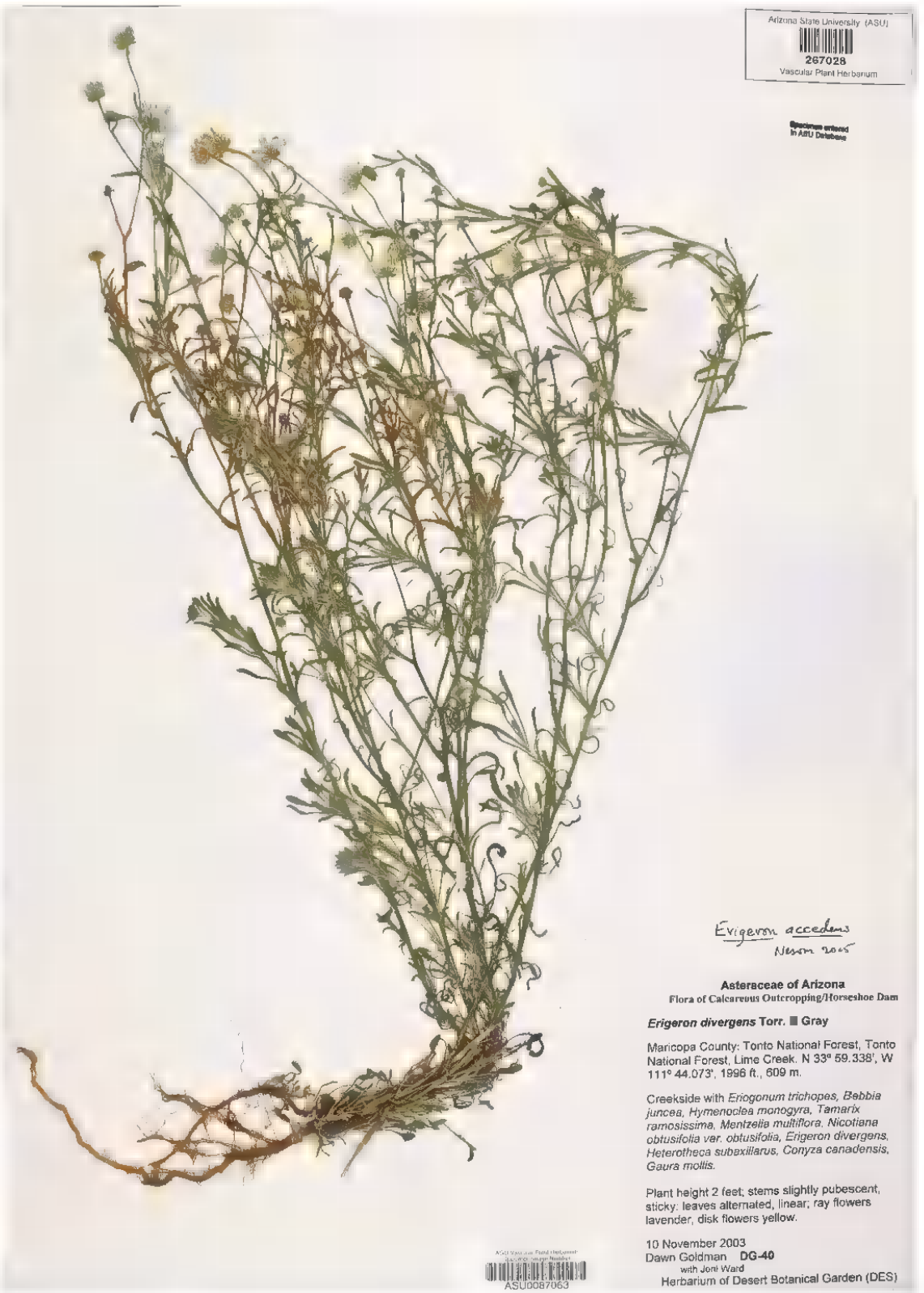
Arizona State University (ASU)
267028
Vascular Plant Herbarium
Specimen entered in ASU Database
Erigeron accedens
Nesom 2005
Asteraceae of Arizona
Flora of Calcareous Outcropping/Horseshoe Dam
Erigeron divergens Torr. ■ Gray
Maricopa County: Tonto National Forest, Tonto National Forest, Lime Creek. N 33° 59.338', W 111° 44.073', 1996 ft., 609 m.
Creekside with Eriogonum trichopes, Bebbia juncea, Hymenoclea monogyra, Tamarix ramosissima, Mentzelia multiflora, Nicotiana obtusifolia var. obtusifolia, Erigeron divergens, Heterotheca subaxillaris, Conyza canadensis, Gaura mollis.
Plant height 2 feet; stems slightly pubescent, sticky; leaves alternated, linear; ray flowers lavender, disk flowers yellow.
10 November 2003
Dawn Goldman DG-40
with Joni Ward
Herbarium of Desert Botanical Garden (DES)
ASU0087063

Figure 10. *Erigeron incomptus*, Maricopa Co., Arizona.

Figure 11. *Erigeron incomptus*, Pima Co., Arizona.

Figure 12. *Erigeron incomptus*, Pima Co., Arizona.

Figure 13. *Erigeron incomptus*, Pima Co., Arizona.

Figure 14. *Erigeron incomptus*, Graham Co., Arizona. Basal and lower leaves are mostly entire, but note pinnate teeth on one leaf.

Figure 15. *Erigeron incomptus*, Gila Co., Arizona, *Little 4242* (ASU). Multicipital caudex with characteristic, numerous meristematic apices. The plant apparently was divided in half upon its collection for a specimen.

Figure 16. *Erigeron incomptus*, Yavapai Co., Arizona. Chromosome number $2n = 27$.

Erigeron accedens
Nesom 2015
Chromosome count from this plant
3 n = 27 I
Determined by DAVID J. KEIL 1975
Erigeron divergens T.&G. var. divergens
det. David J. Keil '75
Annotation - Herbarium of Arizona State University
Franklin College Summer Ecology Trip
PLANTS OF ARIZONA
Erigeron
Gila Co.: ca. 15 mi SE of Globe. Desert hillside. Rays white, disc yellow. Common on roadside.
ASU0087079
David Keil no. 10794
1 June 1975

Figure 17. *Erigeron incomptus*, Gila Co., Arizona. Chromosome number $2n = 27$.

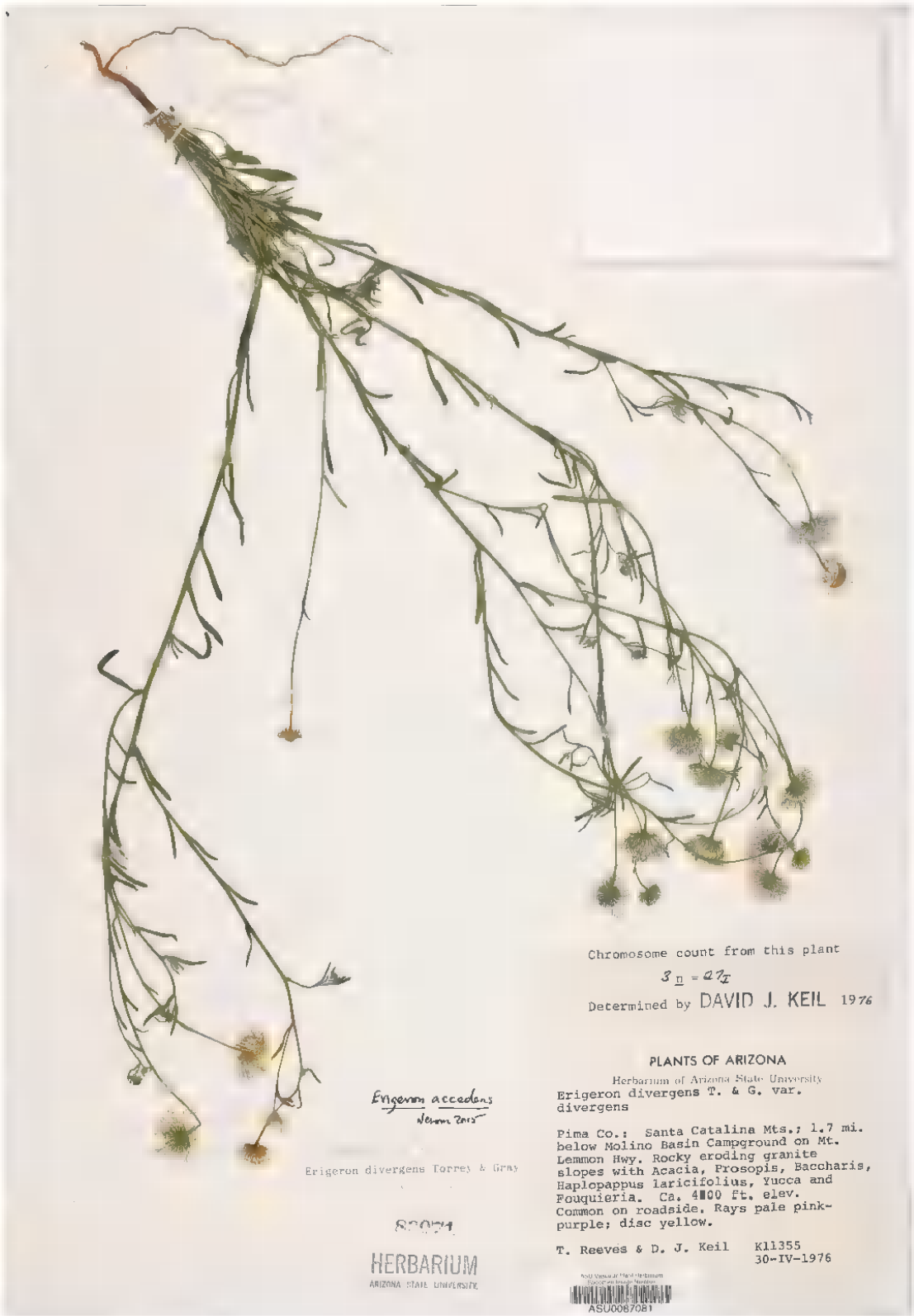
Chromosome count from this plant
3 n = 27
Determined by DAVID J. KEIL 1976
PLANTS OF ARIZONA
Herbarium of Arizona State University
Erigeron divergens T. & G. var. divergens
Pima Co.: Santa Catalina Mts.; 1.7 mi. below Molino Basin Campground on Mt. Lemmon Hwy. Rocky eroding granite slopes with Acacia, Prosopis, Baccharis, Haplopappus laricifolius, Yucca and Fouquieria. Ca. 4■00 ft. elev. Common on roadside. Rays pale pink-purple; disc yellow.
T. Reeves & D. J. Keil K11355
30-IV-1976
Erigeron accedens
Nesom 2015
Erigeron divergens Torrey & Gray
HERBARIUM
ARIZONA STATE UNIVERSITY
ASU0087081

Figure 18. *Erigeron incomptus*, Pima Co., Arizona. Chromosome number $2n = 27$.

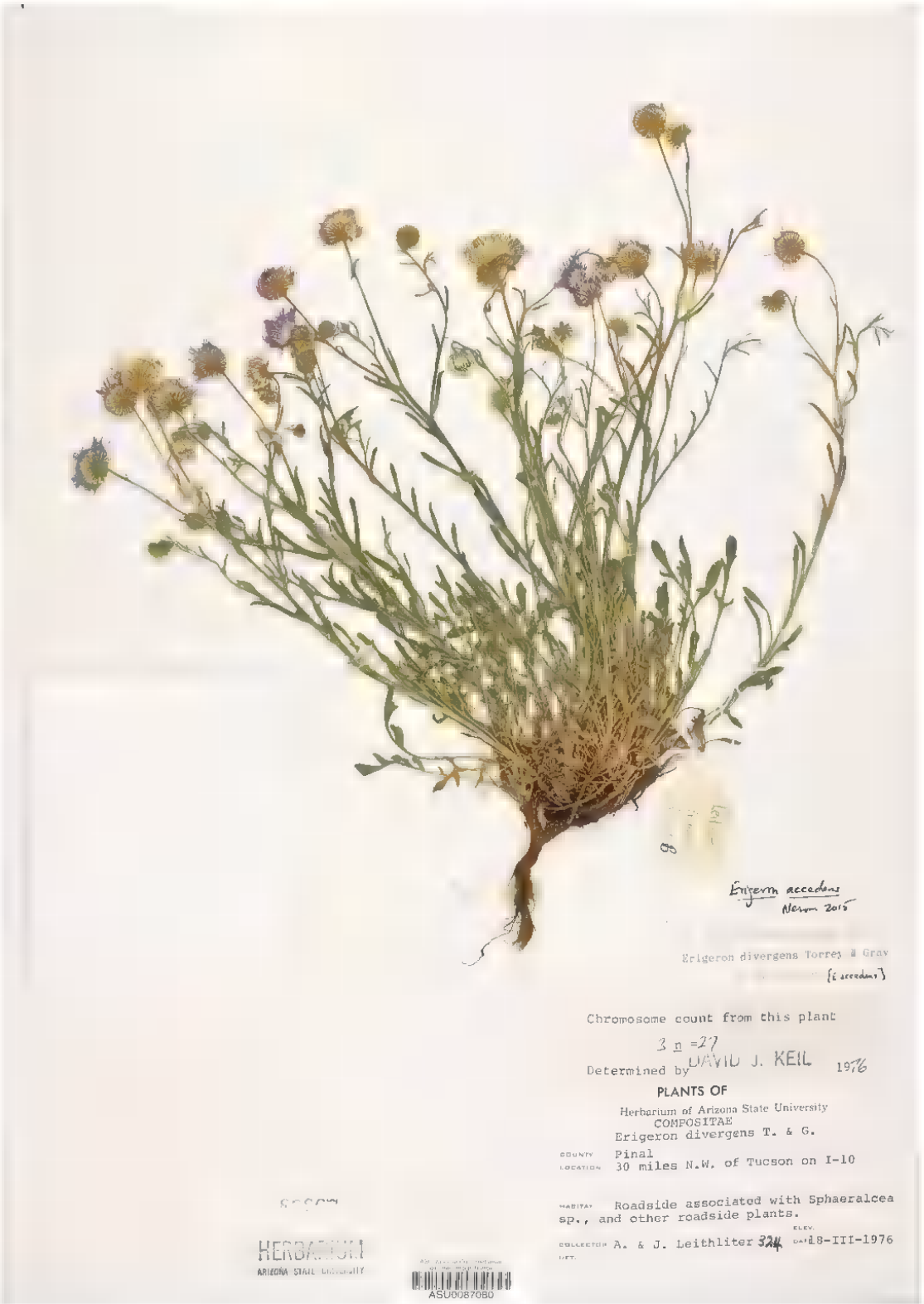

Figure 19. *Erigeron* aff. *incomptus*, Pinal Co., Arizona, perhaps a hybrid with *E. tracyi*. Chromosome number $2n = 27$.

Egger, J.M. 2015. Range extension and first Montana records for *Castilleja puberula* Rydb. (Orobanchaceae). Phytoneuron 2015-62: 1–8. Published 23 November 2015. ISSN 2153 733X

RANGE EXTENSION AND FIRST MONTANA RECORDS FOR *CASTILLEJA PUBERULA* RYDB. (OROBANCHACEAE)

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ABSTRACT

Two recent collections of the rare plant species *Castilleja puberula* Rydb. are reported for Montana. These records document a wide disjunction in and extension of the range of *C. puberula*, which was previously known only from 6 counties in the Rocky Mountains of north-central Colorado.

This paper reports a substantial disjunction in and extension for the range of the rare plant species *Castilleja puberula* Rydb. Until recently, *C. puberula* was only known from alpine plant communities in the Rocky Mountains of north-central Colorado, in Boulder, Clear Creek, Gilpin, Grand, Larimer, and Park counties (Ackerfield 2015; Colorado Rare Plant Technical Committee 2015; Hartman & Nelson 2001; Weber & Wittman 2012), and it was regarded as endemic to Colorado (J. Ackerfield, pers. comm. 2015). *Castilleja puberula* is a listed species of management concern, both in Colorado, where it is listed as S2-S3, as well as globally as G2-G3 (Colorado Rare Plant Technical Committee 2015).

In late 2014, Dick Olmstead (WTU) shared some photos he obtained of an unusual *Castilleja* species he collected in August 2014 near the summit of Mount Jefferson, a peak on the Continental Divide in the Centennial Range in Beaverhead Co., southwestern Montana, and close to the border of Fremont Co., Idaho (Figs. 1-2). It was quickly evident that these plants were unlike the usual *Castilleja* species known from Montana and they most closely resembled *C. puberula*. While searching the web site of the Consortium of Pacific Northwest Herbaria for similar plants, Olmstead noted a collection ten years earlier of a similar species from virtually the same location by Montana botanist Peter Lesica, a sheet of which was obtained on loan from MONTU. Lesica's collection was initially identified as *C. flava* S. Wats., a similar but considerably taller species found primarily in sagebrush habitats at moderate elevations, though a later annotation by Lesica linked his collection to *C. nivea* Pennell & M. Ownbey, another yellowish alpine *Castilleja* known from several mountain ranges in Montana and adjacent Wyoming. However, *C. nivea* has calyces divided into four subequal lobes, whereas the Mount Jefferson plants have calyces divided deeply in the adaxial-abaxial plane but cleft much more shallowly in the lateral plane.

Subsequent examination of both the Olmstead (Figs. 3-4) and Lesica (Figs. 5-6) collections and comparison with collections of *Castilleja puberula* from Colorado allowed positive identification of the Montana plants as belonging to that species. Specimen citations are provided below.

Montana. Beaverhead Co.: Centennial Range, common in stony limestone soil just below the summit of Mount Jefferson, T15S R2E S5, 10,150 ft, with *Dryas octopetala* and *Silene acaulis*, 16 Jul 2004, *Lesica 8884* (MONTU, NY); alpine meadows on upper slopes of Mount Jefferson, 44.56157° N, 111.50415° W, in rocky alpine meadow, 3090 m, plants circa 15 cm tall, flowers yellow, 19 Aug 2014, *Olmstead 2014-132* (ID, WTU). Figure 7 shows the locality.

These collections of *Castilleja puberula* are the fist and second for Montana and also represent the first known occurrence of this species outside of Colorado. This population represents a disjunction of approximately 600 km from the nearest populations in Colorado. Plants of the Montana

population are remarkably similar to the Colorado plants and show little, if any, morphological divergence. The large gap between the Colorado and Montana populations is difficult to explain, and *C. puberula* should be looked for in similar limestone alpine situations in the intervening mountains, especially in Wyoming.

ACKNOWLEDGEMENTS

I thank David Giblin (WTU) and Peter Lesica (MONTU) for assistance with loans and Maria Yousoufian (WTU) for imaging the herbarium specimens. My sincere gratitude is also extended to Richard Olmstead (WTU) and Peter Lesica for sharing their collections and photographs of live plants and for their reviews of an earlier draft of this paper. Finally, Jennifer Ackerfield (CS) generously provided timely information about the present status of *Castilleja puberula* in Colorado.

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Colorado Rare Plant Technical Committee. 2015. Colorado Rare Plant Guide. Colorado Natural Heritage Program. <http://www.cnhp.colostate.edu/download/projects/rareplants/guide.asp?id= 17753> Accessed 9 Aug 2015

Hartman, R.L. and B.E. Nelson. 2001. A Checklist of the Vascular Plants of Colorado. Rocky Mountain Herbarium, Univ. of Wyoming, Laramie.

Weber, W.A. and R.C. Wittmann. 2012. Colorado Flora, Eastern Slope: A Field Guide to the Vascular Plants (ed. 4). University Press of Colorado, Boulder.

Figure 1. *Castilleja puberula* at the collection site on Mount Jefferson, *Olmstead 2014-132* (WTU), second collection for Montana. Photo by R.G. Olmstead.

Figure 2. *Castilleja puberula* at the collection site, *Olmstead 2014-132* (WTU). Photo by R.G. Olmstead.

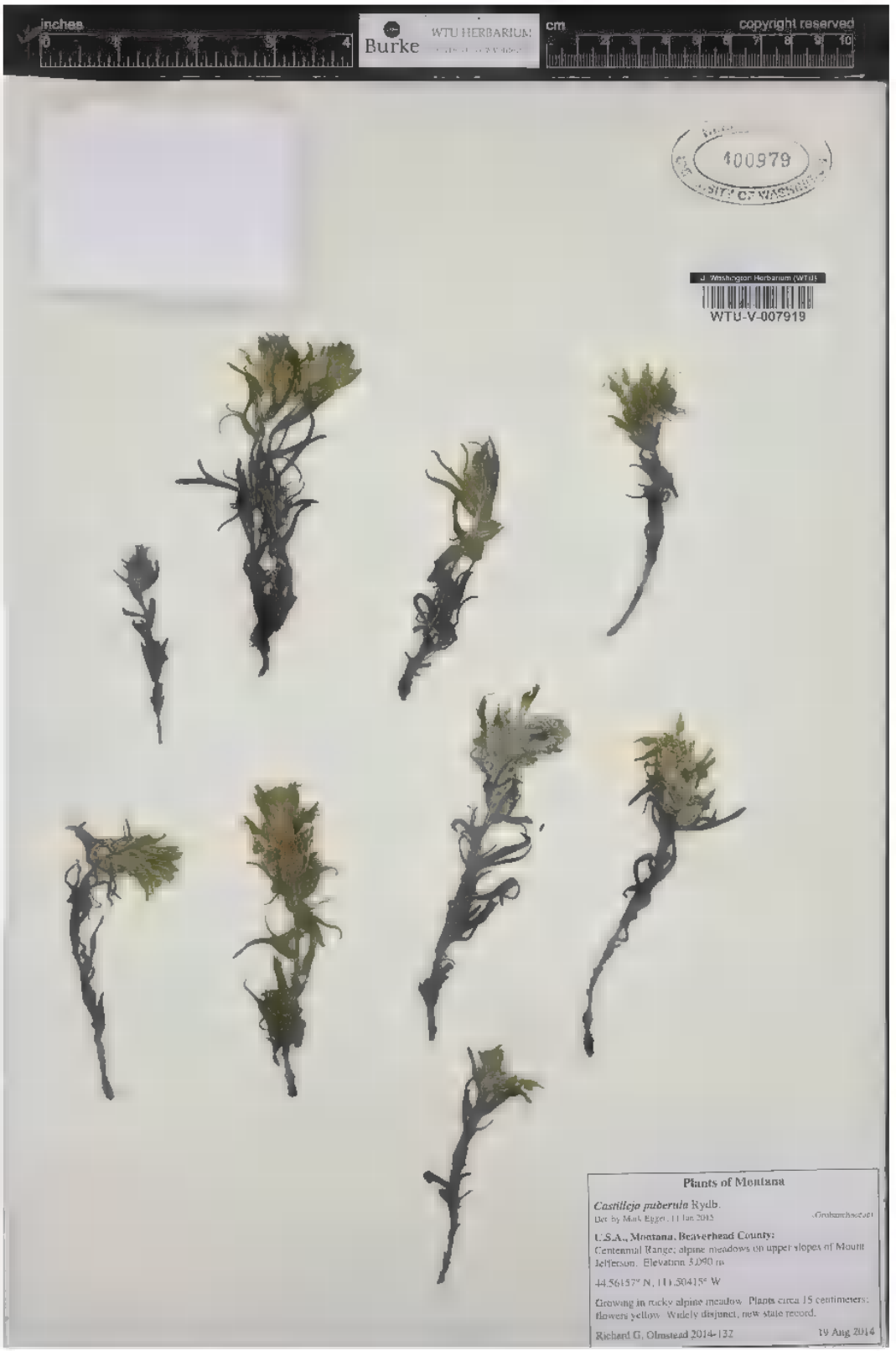
inches
Burke
WTU HERBARIUM
cm
copyright reserved
400979
WTU-V-007919
Plants of Montana
Castilleja puberula Rydb.
Det by Mark Egger, 11 Jan 2015
U.S.A., Montana, Beaverhead County:
Centennial Range; alpine meadows on upper slopes of Mount Jefferson. Elevation 3,090 m
44.56157° N, 111.50415° W
Growing in rocky alpine meadow. Plants circa 15 centimeters; flowers yellow. Widely disjunct, new state record.
Richard G. Olmstead 2014-132
19 Aug 2014

Figure 3. Full sheet of *Olmstead 2014-132* (WTU).

Figure 4. Cropped specimens from *Olmstead 2014-132* (WTU).

Castilleja puberula Rydb.
Determined by EGGER, 2/6/2015
the University of Washington.
1ST RECORD FOR MONTANA!
Castilleja nivea Pennell & Owenby
Determined by P. Lesica 10-07
0 1 2 3 4 5 6 7 8 9 10
cm
copyright reserved
UNIVERSITY OF WASHINGTON
PLANTS OF MONTANA
Centennial Range Beaverhead Co.
Castilleja flava Wats.
Common in stony limestone soil just below the summit of Mount Jefferson. 10,150 ft. T15S R2E S5.
With Dryas octopetala and Silene acaulis.
16 July 2004 #8884
Collected by Peter Lesica
HERBARIUM
UNIVERSITY OF MONTANA

Figure 5. Full sheet of *Lesica 8884* (MONTU), first collection of *Castilleja puberula* in Montana.

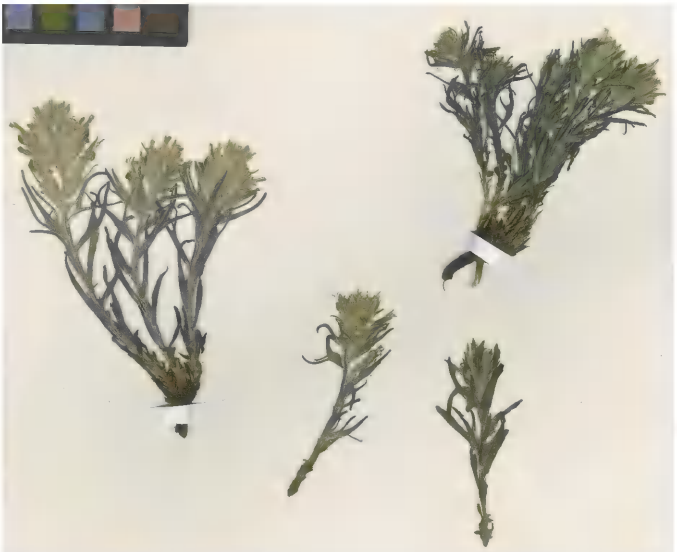

Figure 6. Cropped specimens from *Lesica 8884* (MONTU).

Figure 7. Habitat of *Castilleja puberula* near summit of Mount Jefferson, Beaverhead Co., Montana — site of both collections cited here as range extensions. The relatively flat-topped peak in the middle distance is Sawtell Peak, with the Yellowstone Plateau in the background. Photo by R.G. Olmstead.

Ruiz-Guerrero, M., T.R. Van Devender, A.L. Reina-Guerrero, P. Mejía-Mora, and A.M. van der Heiden. 2015. A preliminary checklist of the vascular plant flora of La Guásima, southern Sinaloa, northwestern Mexico. Phytoneuron 2015-63: 1–25.

A PRELIMINARY CHECKLIST OF THE VASCULAR PLANT FLORA OF LA GUÁSIMA, SOUTHERN SINALOA, NORTHWESTERN MEXICO

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ABSTRACT

A preliminary checklist is provided for the vascular plant flora of the communal area La Guásima located in the western foothills of the Sierra Madre Occidental in southern Sinaloa, northwestern Mexico. Vegetation in the area includes tropical deciduous forest, tropical subdeciduous forest, oak woodland, edaphic grassland, and riparian vegetation. A total of 785 species and infraspecific taxa of vascular plants, belonging to 434 genera and 105 families have beren recorded in this area since we started collecting in 2003. Our floristic inventories are part of the documentation of the biodiversity to support the establishment of La Guásima as a federal Protected Natural Area.

RESUMEN

Se presenta un listado florístico preliminar de la flora vascular de la Comunidad La Guásima, localizada al pie de la Sierra Madre Occidental en el sur de Sinaloa, en el noroeste de México. Los tipos de vegetación presentes incluyen el bosque tropical caducifolio, bosque tropical subcaducifolio, bosque de *Quercus*, pastizal edáfico y vegetación riparia. Hemos registrado 785 especies y taxones infraespecíficos, en 434 géneros y 105 familias, desde que iniciamos nuestras recolectas en 2003. Este inventario florístico documenta la biodiversidad para apoyar la designación de La Guásima como un Área Natural Protegida federal.

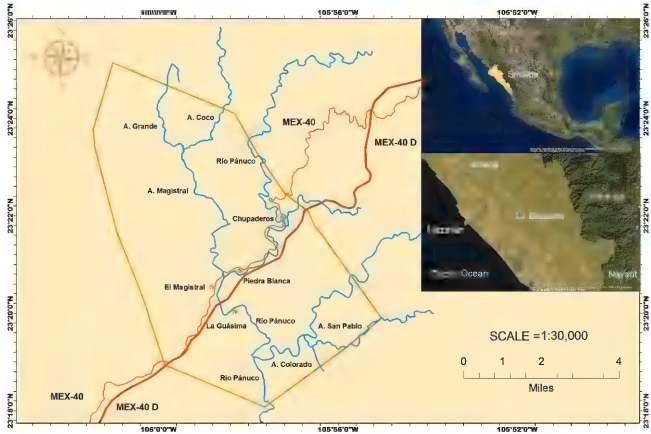

Figure 1. Map of La Guásima, situated in southern Sinaloa and northwestern Mexico. The Mazatlán-Durango highway Mex-40 and toll road Mex-40D cross the community southwest to northeast. Chupaderos, La Guásima, El Magistral, and Piedra Blanca are the main centers of population. All arroyos are tributaries to the Río Pánuco.

La Guásima, a communal area of 7880.58 hectares, is situated in the Municipio (= County) de Concordia in southern Sinaloa, between the northern and southern extremes of 23°25'08" N - 106°01'01" W and 23°18'05" N - 105°57'39" W, respectively; some 45 minutes driving distance from the city of Mazatlán (Figure 1). Several types of vegetation exist in the area along an elevational gradient from 200 to 900 meters: tropical deciduous forest (the most abundant), tropical subdeciduous forest, oak woodland, edaphic grassland, and riparian vegetation.

For centuries, the vegetation and flora of southern Sinaloa were strongly impacted without regulation by human activities, including slash and burn farming, extensive livestock farming, local timber harvesting, and deforestation for domestic charcoal production. Through management programs, conservation of natural resources, and environmental education, agriculture has been limited to restricted areas, logging limited, and charcoal production eliminated. Documenting the diversity of flora and fauna was part of an effort to protect the rich biota of the La Guásima region (Guido-Sánchez et al. 2006; Ruiz-Guerrero et al. in press). In 2005, the National Commission of Natural Protected Areas (CONANP), the federal agency in charge of protecting natural areas in Mexico, declared La Guásima as a Priority Region for Conservation. Recently, in 2014, the favorable experience and results with La Guásima led to the proposal to create a new Natural Protected Area called Monte Mojino in southern Sinaloa, which, apart from La Guásima, includes another 96 properties comprising a total of 201,279 hectares (CONANP 2014).

Here, we present the results of our floristic inventories of La Guásima from 2003 to date, using the Missouri Botanical Garden's Tropicos database (Tropicos 2015) as our main online taxonomic resource. Currently, 785 taxa of vascular plants in 434 genera and 105 families are known in the La Guásima flora, representing 28.1% of the 2792 species, 44.3% of the 978 genera, and 51.9% of the 202 families reported for the state of Sinaloa by Vega-Aviña et al. (2000). Only 23 species (2.9%) are not native to Mexico, the majority (14) of them in the Poaceae. *Ageratina concordiana* (see Turner 2012; Figure 2) and *Koanophyllon concordianum* (see Turner 2009; Figure 3) were described from our Guásima collections, and two more species are in the process of description (*Viguiera* sp. nov. and *Wedelia* sp. nov., B.L. Turner, pers. comm. 2012).

The study of the floristic richness of La Guásima has provided important regional knowledge of the plants of the west flank of the Sierra Madre Occidental in tropical southern Sinaloa. A new herbarium was created to house the specimens in the Mazatlán Unit of the Research Center for Food and Development (CIAD), a public institute dedicated to research, offering graduate degree programs. Specialists from many academic institutions in the USA and Mexico helped identify specimens in more difficult groups. In the near future, all information about the specimens deposited in the CIAD-Mazatlán Regional Herbarium (http://www.ciad.mx/herbario) will be publicly available through the Southwestern Environmental Information Network web portal (SEINET 2015) under its portlet Herbaria of Northwestern Mexico.

Figure 2. *Ageratina concordiana* B.L. Turner, a new species of Asteraceae: Eupatorieae, from La Guásima. Photo by Marcela Ruiz, 3 March 2010, taken together with holotype, Cerro El Pirame, La Guásima.

Figure 3. *Koanophyllon concordianum* B.L. Turner, a new species of Asteraceae: Eupatorieae, from La Guásima. Photo by Marcela Ruiz, 18 October 2009, Cerro El Pirame, La Guásima.

VASCULAR PLANTS OF LA GUÁSIMA, SINALOA, MEXICO

Species non-native to Mexico are indicated with an asterisk. Vegetation types where the species occur are tropical deciduous forest (TDF), tropical subdeciduous forest (TSF), oak woodland (OW), edaphic grassland (EG), and riparian vegetation (RV).

PTERIDOPHYTA

ANEMIACEAE	
Anemia affinis Baker	TDF, TSF, OW
Anemia jaliscana Maxon	TSF,OW
Anemia pastinacaria Moritz ex Prantl	TSF
BLECHNACEAE	
Blechnum polypodioides Raddi	TSF
DRYOPTERIDACEAE	
Dryopteris knoblochii A.R. Sm.	TSF
Dryopteris rossii C. Chr.	OW

LYGODIACEAE	
Lygodium venustum Sw.	TSF
PTERIDACEAE	
Adiantopsis seemannii (Hook.) Maxon	TDF
Adiantum amplum C. Presl	TSF
Adiantum braunii Mett ex Kuhn	TDF
Adiantum patens Willd.	OW
Adiantum philippense L.	TSF
Adiantum poiretii Wikstr.	TDF, TSF
Adiantum tricholepis Fée	TDF, TSF
Cheilanthes cf. *chaerophylla* (Mart. & Gal.) Kunze	TDF
Cheilanthes cf. hirsuta Link	TDF
Gaga angustifolia (Kunth) F.W. Li & Windham	OW
Hemionitis subcordata (D.C. Eat. ex Davenp.) Mickel	TDF
Pityrogramma calomelanos (L.) Link var. *calomelanos*	OW
SELAGINELLACEAE	
Selaginella hoffmannii Hieron.	TDF, TSF
Selaginella marginata (Humb. & Bonpl. ex Willd.) Spring	TDF, TSF
Selaginella pallescens (C. Presl) Spring	TDF, TSF
Selaginella porphyrospora A. Braun	TSF
Selaginella schaffneri Hieron.	TSF
Selaginella tarda Mickel & Beitel	TSF
Selaginella tenella (P. Beauv.) Spring	TSF
WOODSIACEAE	
Athyrium skinneri (Baker) Diels	TDF, TSF
PINACEAE	
Pinus oocarpa Schiede ex Schltdl.	OW
DICOTYLEDONEAE	
ACANTHACEAE	
Aphelandra madrensis Lindau	TSF
**Barleria oenotheroides* Dum. Cours.	TDF
Blechum pyramidatum (Lam.) Urb.	TDF, RV
Carlowrightia arizonica A. Gray	TDF
Dicliptera nervata Greenm.	TDF
Dicliptera resupinata (Vahl) Juss.	TDF,TSF
Dyschoriste hirsutissima (Nees) Kuntze	TDF, TSF
Elytraria imbricata (Vahl) Pers.	TDF, TSF, OW
Henrya insularis Nees	TDF
Justicia caudata A. Gray	TDF, TSF
Justicia hilsenbeckii T.F. Daniel	TSF, OW
Justicia ixtlania T.F. Daniel	TSF
Justicia salviiflora Kunth	TDF
Ruellia imundata Kunth	TDF, TSF
Tetramerium nervosum Nees	TDF, TSF, OW
Tetramerium tenuissimum Rose	TDF

AIZOACEAE	
Trianthema portulacastrum L.	TDF, RV
AMARANTHACEAE (includes Chenopodiaceae)	
Achyranthes aspera L.	TSF
Amaranthus spinosus L.	TDF
**Chenopodium murale* L.	TDF
Gomphrena cf. *caespitosa* Torr.	TDF
Gomphrena sonorae Torr.	TDF
Iresine angustifolia Euphrasén	TDF
Iresine interrupta Benth.	RV
Iresine serrata L.	TDF
ANACARDIACEAE	
Comocladia macrophylla (Hook. & Arn.) L. Riley	TSF, RV
ANNONACEAE	
Annona reticulata L.	TDF, TSF
Annona squamosa L.	TDF
Sapranthus microcarpus (Donn. Sm.) R.E. Fr.	TSF
APIACEAE	
Eryngium nasturtiifolium Juss. ex F. Delaroche	OW
APOCYNACEAE (includes Asclepiadaceae)	
Asclepias curassavica L.	TDF
Asclepias ovata Mart. & Gal.	OW
Cascabela ovata (Cav.) H. Lippold	TDF, TSF
Echites yucatanensis Millsp. ex Standl.	TDF, TSF
Funastrum clausum (Jacq.) Schltr.	TDF
Funastrum pannosum Schltr.	TDF
Gonolobus sp	TDF
Laubertia contorta (Mart. & Gal.) Woodson	TDF, TSF
Mandevilla hypoleuca (Benth.) Pichon	OW
Marsdenia edulis S. Wats.	TDF
Matelea cyclophylla (Standl.) Woodson	TSF
Plumeria rubra L.	TDF, RV
Prestonia mexicana A. DC.	TSF
Rauvolfia tetraphylla L.	TSF
Stemmadenia tomentosa Greenm.	TDF, TSF
ARALIACEAE	
Dendropanax arboreus (L.) Decne. & Planch.	TSF, RV
ARISTOLOCHIACEAE	
Aristolochia buntingii Pfeifer	TDF
Aristolochia taliscana Hook. & Arn.	TDF
ASTERACEAE	
Acmella oppositifolia (Lam.) R.K. Jansen var. *oppositifolia*	RV
Acmella radicans (Jacq.) R.K. Jansen var. *radicans*	TDF, RV

Adenophyllum cancellatum (Cass.) Villareal	TDF, EG
Ageratella microphylla (Sch. Bip.) A. Gray ex S. Wats. var. *microphylla*	OW, EG
Ageratina choricephala (B.L. Rob) R.M. King & H. Rob	TDF
Ageratina concordiana B.L. Turner.	TSF, OW
Ageratina malacolepis (B.L. Rob) R.M. King & H. Rob	TSF
Ageratum conyzoides L.	RV
Ageratum corymbosum Zucc.	OW, EG
Ambrosia ambrosioides (Cav.) W.W. Payne	TDF
Baccharis salicifolia (Ruiz & Pav.) Pers.	TSF, RV
Baltimora geminata (Brandegee) Stuessy	TDF
Bidens leptocephala Sherff	TSF, RV
Bidens mexicana Sherff	RV
Bidens oligantha Brandegee	OW
Bidens riparia Kunth	TDF, OW
Bidens rostrata Melchert	TDF
Bidens valladolidensis Sch. Bip. [new name for *Cosmos crithmifolius* Kunth]	OW
Brickellia coulteri A. Gray var. *adenopoda* (B.L. Rob.) B.L. Turner	TDF
Brickellia diffusa (Vahl) A. Gray	TDF
Brickellia subuligera (S. Schauer) B.L. Turner	TDF, EG
Calea urticifolia (Mill.) DC. var *urticifolia*	TDF
Centratherum punctatum Cass.	TDF
Chloracantha spinosa var. *jaliscensis* (McVaugh) S.D. Sundb.	TSF, RV
Chromolaena collina (DC.) R.M. King & H. Rob.	TDF, TSF
Chromolaena haenkeana (DC.) R.M. King & H. Rob.	TSF
Chromolaena odorata (L.) R.M. King & H. Rob.	TDF, TSF
Chromolaena ovalifolia (Hook. & Arn.) R.M. King & H. Rob.	TDF
Cosmos sulphureus Cav.	TDF
Critonia quadrangularis (DC.) R.M. King & H. Rob.	TDF
Dahlia coccinea Cav.	OW
Decachaeta haenkeana DC.	TDF
Delilia biflora (L.) Kuntze	TDF, TSF
Eclipta prostrata (L.) L.	TSF
Erigeron sp.	RV
Galinsoga parviflora Cav.	OW
Koanophyllon albicaule (Sch. Bip. ex Klatt) R.M. King & H. Rob.	RV
Koanophyllon concordianum B.L. Turner	OW
Koanophyllon monanthum (Sch. Bip.) T.J. Ayers & B.L. Turner	TSF
Koanophyllon palmeri (A. Gray) R.M. King & H. Rob. var. *palmeri*	TDF, EG
Koanophyllon sinaloense B.L. Turner	OW
Laennecia sophiifolia (Kunth) G.L. Nesom	OW
Lagascea decipiens Hemsl.	TDF
Lasianthaea ceanothifolia (Willd.) K.M. Becker var. *gracilis* (W.W. Jones) K.M. Becker	TDF
Lasianthaea macrocephala (Hook. & Arn.) K.M. Becker	TDF, OW
Lasianthaea zinnioides (Hemsl.) K.M. Becker	OW
Melampodium appendiculatum B.L. Rob.	EG
Melampodium divaricatum (Rich.) DC.	TDF, TSF
Melampodium rosei B.L. Rob.	TDF
Melampodium tenellum Hook. & Arn.	TDF

Montanoa leucantha (Lag.) S.F. Blake var. *arborescens* (DC.) B.L.Turner	TDF
Otopappus tequilanus (A. Gray) B.L. Rob. var. *tequilanus*	TDF
Oxypappus scaber Benth.	OW
Parthenium hysterophorus L.	TDF
Pectis prostrata Cav.	TDF, EG, RV
Pectis uniaristata DC. var. *jangadensis* (S. Moore) D.J. Keil	TDF, EG
Pectis uniaristata DC. var. *uniaristata*	TDF, EG
Perityle microglossa Benth. var. *microglossa*	TDF
Perymenium beckeri J.J. Fay	OW
Pluchea salicifolia (Mill.) S.F. Blake	TSF. RV
Porophyllum coloratum (Kunth) DC.	TDF, OW
Porophyllum macrocephalum DC.	TDF, OW
Psacalium pachyphyllum (Sch. Bip.) Rydb.	TDF, OW
Pseudognaphalium luteoalbum (L.) Hilliard & B.L. Burtt	OW
Pseudelephantopus spicatus (Juss. ex Aubl.) C.F. Baker	TDF
Sclerocarpus divaricatus (Benth.) Benth. & Hook. f. ex Hemsl.	TDF
Sonchus oleraceus L.	TDF
Stenocarpha filiformis (Hemsl.) S.F. Blake	TDF
Tagetes erecta L.	TDF
Tagetes subulata Cerv.	EG
Tagetes tenuifolia Cav.	TSF, RV
Tithonia calva Sch. Bip. var. *auriculata* (Brandegee) La Duke	OW, EG
Tithonia calva Sch. Bip. var. *lancifolia* (B.L. Rob. & Greenm.) McVaugh	OW
Tithonia tubiformis (Jacq.) Cass	TDF
Tridax procumbens L.	TDF
Trixis pterocaulis B.L. Rob. & Greenm.	TDF
Vernonia patens Kunth	TDF
Vernonia serratuloides Kunth	TDF
Viguiera sp. nov. B.L. Turner (unpublished)	TDF
Wedelia sp. nov. B.L. Turner (unpublished)	OW
Wedelia scabra (Cav.) B.L. Turner	TDF
Zinnia angustifolia Kunth var. *angustifolia*	TDF
Zinnia angustifolia Kunth var. *littoralis* (B.L. Rob. & Greenm.) B.L. Turner	OW
Zinnia zinnioides (Kunth) Olorode & Torres	TDF
BEGONIACEAE	
Begonia heracleifolia Schltdl. & Cham.	TDF, TSF
Begonia jaliscana Burt-Utley	EG
Begonia portillana S. Wats.	TSF
Begonia stigmosa Lindl.	TSF
Begonia uruapensis Sessé & Moc.	TDF, OW, EG
BIGNONIACEAE	
Adenocalymma imundatum Mart. ex DC.	TDF, EG
Amphilophium paniculatum (L.) Kunth	TDF
Crescentia alata Kunth	TDF
Cydista aequinoctialis (L.) Miers	TDF, TSF
Macfadyena unguis-cati (L.) A.H. Gentry	TDF, TSF

Tabebuia chrysantha G. Nicholson	TDF
Tabebuia impetiginosa (Mart. ex DC.) Standl.	TDF
Tabebuia rosea (Bertol.) A. DC.	TSF
BIXACEAE	
Amoreuxia palmatifida DC.	OW
Cochlospermum vitifolium (Willd.) Spreng.	TDF
BORAGINACEAE	
Cordia alliodora (Ruiz & Pav.) Oken	TDF, TSF, RV
Heliotropium angiospermum Murray	TDF
Heliotropium fruticosum L.	TDF
Heliotropium indicum L.	TDF
Tournefortia hartwegiana Steud.	TDF
Tournefortia mutabilis Vent.	TDF
BURSERACEAE	
Bursera excelsa (Kunth) Engl.	TDF, OW
Bursera fagaroides (Kunth) Engl.	TDF
Bursera grandifolia (Schltdl.) Engl.	TSF
Bursera simaruba (L.) Sarg.	TDF, TSF, RV
CACTACEAE	
Acanthocereus tetragonus (L.) Hummelinck	TDF, TSF
Echinocereus subinermis Salm-Dyck ex Scheer subsp. *ochoterenae* (J.G. Ortega) N.P. Taylor	TDF, OW
Hylocereus purpusii (Weing.) Britton & Rose	TSF
Nopalea karwinskiana (Salm-Dyck) K. Schum.	TDF., TSF
Opuntia puberula Pfeiff.	TDF
Opuntia wilcoxii Britton & Rose	TDF, OW
Pachycereus pecten-aborigimum (Engelm. ex S. Wats.) Britton & Rose	TDF, TSF
Pereskiopsis aquosa (F.A.C. Weber) Britton & Rose	TSF, RV
Pilosocereus alensis (F.A.C. Weber) Byles & G.D. Rowley	TSF
Stenocereus kerberi (K. Schum.) A.C. Gibson & K.E. Horak	TDF
CAMPANULACEAE	
Lobelia sp.	TDF
CANNABACEAE	
Aphananthe monoica (Hemsl.) J.-F. Leroy	TDF
Celtis iguanaea (Jacq.) Sarg.	TDF, TSF
Celtis pallida Torr.	TDF, TSF
Trema micrantha (L.) Blume	TDF
CAPPARACEAE	
Capparis verrucosa Jacq.	TDF
Crateva tapia L.	TDF, TSF
Morisonia americana L.	TDF

CARYOPHYLLACEAE	
Drymaria villosa Schltdl. & Cham. subsp. *palustris* (Schltdl. & Cham.) J.A. Duke	RV
CELASTRACEAE	
Hippocratea aff. *volubilis* L.	TDF
Wimmeria mexicana (DC.) Lundell	TDF, EG
CHRYSOBALANACEAE	
Couepia polyandra (Kunth) Rose	TSF, RV
CLEOMACEAE	
Cleome pilosa Benth.	TDF, TSF
**Cleome viscosa* L.	TDF
COMBRETACEAE	
Combretum fruticosum (Loef.) Stuntz	TDF, TSF
CONVOLVULACEAE	
Cuscuta americana L.	TDF, TSF
Cuscuta costaricensis Yunck.	TDF, TSF
Cuscuta gracillima Engelm.	TDF, TSF
Cuscuta macrocephala W. Schaffn. ex Yunck.	TDF, TSF
Cuscuta ortegana Yunck.	TDF, TSF
Evolvulus alsinoides (L.) L.	TDFOW, EG
Evolvulus nummularius (L.) L.	TDF, OW
Ipomoea anisomeres B.L. Rob. & Bartlett	TDF
Ipomoea arborescens (Humb. & Bonpl. ex Willd.) G. Don var. *arborescens*	TDF
Ipomoea bracteata Cav.	TDF, TSF
Ipomoea capillacea (Kunth) G. Don	OW
Ipomoea cristulata Hallier f.	TDF, EG
Ipomoea dumosa (Benth.) L.O. Williams	TDF
Ipomoea hederifolia L.	TDF
Ipomoea indica (Burm.) Merr.	OW
Ipomoea jalapa (L.) Pursh	OW
Ipomoea laeta A. Gray	OW
Ipomoea meyeri (Spreng.) G. Don	TDF
Ipomoea microsepala Benth.	TDF
Ipomoea minutiflora (Mart. & Gal.) House	TDF, TSF
Ipomoea parasitica (Kunth) G. Don	TDF, TSF
Ipomoea pedicellaris Benth.	TDF
Ipomoea proxima Mart. & Gal.	OW
Ipomoea puncticulata Benth.	OW
Ipomoea scopulorum Brandegee	TDF
Ipomoea ternifolia Cav. var. *leptotoma* (Torr.) J.A. McDonald	TDF
Ipomoea trifida (Kunth) G. Don	TDF, TSF
Ipomoea triloba L.	TDF
Merremia palmeri (Hallier) Hallier f.	TDF
Merremia umbellata (L.) Hallier f.	TDF
Operculina pteripes (G. Don) O'Donnell	TDF

Quamoclit vulgaris Choisy [new name for *Ipomoea quamoclit* L.]	TDF
Turbina corymbosa (L.) Raf.	TDF
CUCURBITACEAE	
Apodanthera sp.	RV
Cayaponia attenuata (Hook. & Arn.) Cogn.	TDF
Cucurbita argyrosperma Huber subsp. *sororia* (L.H. Bailey) Merrick & D.M. Bates	TDF
Echinopepon racemosus (Steud.) C. Jeffrey	TDF
Melothria sp.	TDF, TSF
**Momordica charantia* L.	TDF
Polyclathra cucumerina Bertol.	TDF. TSF
Rytidostylis longisepala (Cogn.) C. Jeffrey	TDF
EBENACEAE	
Diospyros sinaloensis S.F. Blake	TDF
ERYTHROXYLACEAE	
Erythroxylum havanense Jacq.	TDF, EG
EUPHORBIACEAE	
Acalypha cincta Müll. Arg.	TDF
Acalypha microphylla Klotzsch	TDF
Acalypha polystachya Jacq.	TDF
Acalypha subviscida S. Wats.	TSF
Cnidoscolus sp.	TSF
Croton draco Schltdl. & Cham.	TSF
Croton hirtus L'Hér.	OW
Croton repens Schltdl.	OW
Croton roxanae Croizat	TDF
Croton varelae V.W. Steinm.	OW
Dalechampia scandens L.	OW, EG
Euphorbia cymosa Poir.	TDF
Euphorbia dioeca Kunth	OW
Euphorbia graminea Jacq.	TDF
Euphorbia heterophylla L.	TSF
Euphorbia hirta L. var. *hirta*	TDF
Euphorbia humayensis Brandegee	TDF
Euphorbia hypericifolia L.	OW
Euphorbia hyssopifolia L.	TDF
Euphorbia ocymoidea L.	TDF
Euphorbia pulcherrima Willd. ex Klotzsch	TSF
Euphorbia subreniformis S. Wats.	TDF
Euphorbia thymifolia L.	TDF
Hura polyandra Baill.	TDF, TSF
Jatropha curcas L.	TDF
Jatropha malacophylla Standl.	TDF
Jatropha peltata Cerv.	TDF
Manihot chlorosticta Standl. & Goldman	OW
Microstachys corniculata (Vahl) Griseb.	OW
Phyllanthus amarus Schumach. & Thonn.	TDF

Phyllanthus coalcomanensis Croizat	TSF
Ricinus communis L.	TDF
Sapium lateriflorum Hemsl.	TDF, TSF
FABACEAE	
Acacia cochliacantha Humb. & Bonpl. ex Willd.	TDF
Acacia farnesiana (L.) Willd.	TDF
Acacia hindsii Benth.	TDF, RV
Acacia macracantha Humb. & Bonpl. ex Willd.	TDF
Acacia pennatula (Schltdl. & Cham.) Benth.	TDF, OW
Aeschynomene americana L. var. *flabellata* Rudd	TDF, RV
Aeschynomene amorphoides (S. Wats.) Rose ex. B.L. Rob.	TDF
Aeschynomene brasiliana (Poir.) DC.	OW
Aeschynomene fascicularis Schltdl. & Cham.	TDF
Aeschynomene petraea B.L. Rob var. *grandiflora* Rudd	TDF
Aeschynomene simulans Rose	OW
Aeschynomene villosa Poir.	RV
Albizia occidentalis Brandegee	TSF
Ancistrotropis peduncularis (Kunth) A. Delgado	OW, EG
Bauhinia pauletia Pers.	TDF, TSF
Bauhinia ungulata L.	TDF, TSF
Brongniartia glabrata Hook. & Arn.	TDF, EG
Caesalpinia pulcherrima (L.) Sw.	RV
Calliandra houstoniana (Mill.) Standl.	OW
Calliandra tergemina (L.) Benth.	TSF
Calopogonium galactioides (Kunth) Benth. ex Hemsl.	TDF, OW
Canavalia acuminata Rose	TDF, TSF
Canavalia brasiliensis Mart. ex Benth.	OW
Centrosema sagittatum (Humb. & Bonpl. ex Willd.) Brandegee	TDF
Chamaecrista nictitans (L.) Moench var. *jaliscensis* (Greenm.) Irwin & Barneby	OW
Chamaecrista punctulata (Hook. & Arn.) Irwin & Barneby	OW
Chamaecrista rotundifolia (Pers.) Greene	OW
Chamaecrista serpens (L.) Greene var. *wrightii* (A. Gray) Irwin & Barneby	OW
Chamaecrista viscosa (Kunth) Irwin & Barneby var. *viscosa*	OW
Chloroleucon mangense (Jacq.) Britton & Rose	TDF
Clitoria polystachya Benth.	OW
Clitoria triflora S. Wats.	OW
Conzattia multiflora (B.L. Rob.) Standl.	TDF
Courbaril hymenaea M. Gómez [new name for *Hymenaea courbaril* L.]	TDF
Coursetia caribaea (Jacq.) Lavin var. *caribaea*	
Coursetia mollis B.L. Rob & Greenm.	TDF, RV
Crotalaria cajanifolia Kunth	TDF
Crotalaria filifolia Rose	OW
Crotalaria mollicula Kunth	TDF
Crotalaria sagittalis L.	TDF
Dalea cliffortiana Willd.	TDF
Dalea foliolosa (Aiton) Barneby	TSF, OW
Desmanthus virgatus (L.) Willd.	TDF

Desmodium affine Schltdl.	TSF
**Desmodium barbatum* (L.) Benth.	OW
Desmodium chartaceum Brandegee	TDF
Desmodium hookerianum D. Dietr.	TDF, RV
Desmodium orbiculare Schltdl. var. *rubricaule* (Rose & Painter) B.G. Schub. & McVaugh	OW
Desmodium procumbens (Mill.) Hitchc. var. *procumbens*	OW
Desmodium psilocarpum A. Gray	RV
Desmodium scorpiurus (Sw.) Desv.	TDF
Desmodium tortuosum (Sw.) DC.	TSF
Diphysa puberulenta Rydb.	TDF
Diphysa suberosa S. Wats.	OW
Entada polystachya (L.) DC.	TDF, TSF
Enterolobium cyclocarpum (Jacq.) Griseb.	TDF, TSF, RV
Erythrina flabelliformis Kearney	TDF
Erythrina lanata Rose subsp. *occidentalis* (Standl.) Krukoff & Barneby	TDF
Eysenhardtia polystachya (Ortega) Sarg.	TDF, EG
Haematoxylum brasiletto H. Karst.	TDF, TSF
Indigofera cuernavacana Rose	TDF
Indigofera suffruticosa Mill.	TDF
Inga eriocarpa Benth.	TSF, RV
Inga vera Willd.	RV
Leptospron gentryi (Standl.) A. Delgado	OW
**Leucaena leucocephala* (Lam.) de Wit.	TDF
Lonchocarpus lanceolatus Benth.	TDF
Lysiloma acapulcense (Kunth) Benth.	OW
Lysiloma auritum (Schltdl.) Benth.	TDF
Lysiloma divaricatum (Jacq.) J.F. Macbr.	TDF
Machaerium salvadorense (Donn. Sm.) Rudd	TDF, TSF
Marina scopa Barneby	OW
Mariosousa russelliana (Britton & Rose) Seigler & Ebinger	TDF, RV
Mimosa affinis B.L. Rob.	TDF, OW
Mimosa albida Humb. & Bonpl. ex Willd. var *glabrior* B.L. Rob.	TDF, OW, EG
Mimosa albida Humb. & Bonpl. ex Willd. var. *strigosa* (Willd.) B.L. Rob.	TDF
Mimosa guatemalensis (Hook. & Arn.) Benth.	TDF, OW, EG
Mimosa occidentalis Britton & Rose	TDF
Mimosa polyantha Benth.	TDF, EG
Mimosa quadrivalvis L. var. *jaliscensis* (Macbr.) Beard ex Barneby	OW
Mimosa sinaloensis Britton & Rose	RV
Mucuna pruriens var. *utilis* (Wall. ex Wight) L.H. Bailey	TDF
Nissolia fruticosa Jacq.	TDF
Phaseolus lunatus L.	TDF
Pithecellobium dulce (Roxb.) Benth.	RV
Platymiscium trifoliolatum Benth.	TDF, TSF
Ramirezella crassa (McVaugh) Ochot.-Booth & A. Delgado	TDF
Rhynchosia minima (L.) DC.	TDF
Rhynchosia precatoria (Humb. & Bonpl. ex Willd.) DC.	TSF
Senegalia riparia (Kunth) Britton	TDF
Senna alata (L.) Roxb.	TDF, RV

Senna atomaria (L.) Irwin & Barneby	TDF
Senna fruticosa (Mill.) Irwin & Barneby	TDF, TSF
Senna hirsuta (L.) Irwin & Barneby var. *hirta* Irwin & Barneby	TDF
Senna mollissima (Humb. & Bonpl. ex Willd.) Irwin & Barneby var. *glabrata* (Benth.) Irwin & Barneby	TDF, TSF
Senna obtusifolia (L.) Irwin & Barneby	TDF
Senna occidentalis (L.) Link	TDF
Senna pallida (Vahl) Irwin & Barneby	TDF, TSF
Senna uniflora (Mill.) Irwin & Barneby	TDF
Sigmoidotropis speciosa (Kunth) A. Delgado	TDF
Stenolobium brachycarpum var. *brachystachyum* Benth. [new name for *Calopogonium mucunoides* Desv.]	TSF, OW
Stylosanthes humilis Kunth	TSF, OW
Stylosanthes mexicana Taub.	TDF
Stylosanthes viscosa (L.) Sw.	TDF, OW
Tephrosia crassifolia Benth.	OW
Tephrosia leucantha Kunth	OW
Tephrosia rhodantha Brandegee	OW
Tephrosia submontana (Rose) Riley	OW
Zapoteca formosa (Kunth) H.M. Hern. subsp. *rosei* (Wiggins) H.M. Hern.	TDF
Zornia reticulata Sm.	OW
FAGACEAE	
Quercus aristata Hook. & Arn.	OW
Quercus magnoliifolia Née	OW
GENTIANACEAE	
Centaurium sp.	TDF, OW
Schultesia guianensis (Aubl.) Malme	EG
GESNERIACEAE	
Achimenes fimbriata (Hook.) Hend.	TSF, OW
Achimenes glabrata (Zucc.) Fritsch	TDF
HERNANDIACEAE	
Gyrocarpus americanus Jacq.	TDF, RV
HYDROLEACEAE	
Hydrolea spinosa L.	TDF, RV
IRIDACEAE	
Nemastylis sp.	TDF
LAMIACEAE	
Hyptis albida Kunth	TDF
Hyptis congesta Leonard	OW
Hyptis rhytidea Benth.	TDF
Hyptis stellulata Benth.	TDF
Hyptis suaveolens (L.) Poit	TDF, TSF, OW, EG
**Leonotis nepetifolia* (L.) R. Br.	TDF

Ocimum basilicum L.	TDF
Salvia lasiocephala Hook. & Arn.	OW
Salvia occidentalis Sw.	TDF
Salvia setosa Fernald	TDF
Stachys pacifica B.L. Turner	TDF, OW
Vitex mollis Kunth	TDF, TSF, RV
Vitex pyramidata B.L. Rob.	TDF, EG
LENTIBULARIACEAE	
Pinguicula sp.	OW
LOASACEAE	
Gronovia scandens L.	TDF
LOGANIACEAE	
Strychnos panamensis Seem.	TDF
LORANTHACEAE	
Ixocactus inconspicuus (Benth.) Kuijt	TDF, OW, EG
Psittacanthus ramiflorus (DC.) G. Don	OW
LYTHRACEAE	
Cuphea appendiculata Benth.	TDF
Cuphea ferrisiae Bacig. var. *ferrisiae*	TDF
Cuphea flavisetula Bacig.	TDF, RV
Cuphea lamimuligera Koehne	OW
Cuphea lobophora Koehne var. *occidentalis* S.A. Graham	OW
Cuphea vesiculigera R.C. Foster	TDF
Rotala ramosior (L.) Koehne	TDF
MALPIGHIACEAE	
Bunchosia palmeri S. Wats.	TDF
Byrsonima crassifolia (L.) Kunth	TSF, OW
Carolus sinemariensis (Aubl.) W.R. Anderson	TDF
Galphimia floribunda C.E. Anderson	TDF, OW
Heteropterys cotinifolia A. Juss.	TDF
Heteropterys laurifolia (L.) A. Juss.	TDF
Heteropterys palmeri Rose	TDF
Tetrapterys schiedeana Schltdl. & Cham.	TDF
MALVACEAE (includes Bombacaceae, Sterculiaceae, Tiliaceae)	
Abutilon trisulcatum (Jacq.) Urb.	TDF
Anoda acerifolia Cav.	TDF
Anoda cristata (L.) Schltdl.	TDF, EG
Ayenia abutilifolia (Turcz.) Turcz.	TDF, TSF
Ayenia glabra S. Wats.	TDF, RV
Ayenia filiformis S. Wats.	TDF, EG
Ayenia jaliscana S. Wats.	TDF
Ayenia wrightii B.L. Rob.	TSF
Briquetia inermis Fryxell	TDF
Briquetia spicata (Kunth) Fryxell	TDF

Byttneria aculeata (Jacq.) Jacq.	TDF
Byttneria catalpifolia Jacq. subsp. *catalpifolia*	TDF
Ceiba acuminata (S. Wats.) Rose	TDF
Corchorus aestuans L.	TDF
Corchorus hirtus L.	TDF
Guazuma ulmifolia Lam.	TDF
Heliocarpus cf. occidentalis Rose	TDF, TSF
Heliocarpus palmeri S. Wats.	TDF
Herissantia crispa (L.) Brizicky	TSF
Malachra capitata (L.) L.	TDF
Malvastrum coromandelianum (L.) Garcke	TDF
Melochia nodiflora Sw.	TDF
Melochia pyramidata L.	TDF
Melochia tomentella (C. Presl) Hemsl.	TDF
Luehea candida (DC.) Mart.	TDF, TSF
Pseudobombax ellipticum (Kunth) Dugand	TDF, TSF, OW
Pseudobombax palmeri (S. Wats.) Dugand	TDF, TSF, OW
Sida aggregata Presl	TDF, TSF, OW, EG
Sida alamosana S. Wats.	TDF
Sida ciliaris L.	TDF
Sida cuspidata (A. Robyns) Krapov.	TDF, RV
Sida glabra Mill.	TSF
Sida hirsutissima Mill.	TDF, TSF
Sida hyssopifolia C. Presl	OW
Sida linifolia Cav.	TDF, OW, EG
Sida rhombifolia L.	TSF, OW
Sida ulmifolia Mill.	OW
Trichospermum insigne (Baill.) Kosterm.	TSF
Triumfetta discolor Rose	OW
Triumfetta galeottiana Turcz.	OW
Triumfetta lappula L.	TDF
Triumfetta paniculata Hook. & Arn.	TDF
Triumfetta cf. *simplicifolia* (Sessé & Moc.) Fryxell	TDF
Waltheria acuminata Rose	TDF
Waltheria indica L.	TDF
Waltheria preslii Walp.	TSF, OW
Wissadula hernandioides (L'Hér.) Garcke	TDF
MARTYNIACEAE	
Martynia annua L.	TDF, TSF
MELASTOMATACEAE	
Clidemia sp.	OW
Conostegia xalapensis (Bonpl.) D. Don ex DC.	TDF, OW
Miconia saxicola Brandegee	EG
Pterolepis trichotoma (Rottb.) Cogn.	OW
MELIACEAE	
Swietenia humilis Zucc.	TDF, TSF
Trichilia hirta L.	TSF

MENISPERMACEAE	
Cocculus diversifolius DC.	TDF
MOLLUGINACEAE	
Mollugo verticillata L.	TDF
MORACEAE	
Brosimum alicastrum Sw.	TSF, RV
Dorstenia drakena L.	TSF, EG
Ficus cotinifolia Kunth	TDF, TSF
Ficus insipida Willd.	TSF, RV
Ficus maxima Mill.	TSF, RV
Ficus pertusa L. f.	TSF
Ficus petiolaris Kunth	TSF
Ficus trigonata L.	TSF
Maclura tinctoria (L.) D. Don ex Steud. subsp. *tinctoria*	TSF
MYRTACEAE	
Eugenia sinaloae Standl.	TDF
Psidium guineense Sw.	TDF, OW
Psidium sartorianum (O. Berg.) Nied.	TDF
NYCTAGINACEAE	
Boerhavia coccinea Mill	TDF
Boerhavia erecta L.	TDF
Pisonia capitata (S. Wats.) Standl	TDF, RV
Salpianthus purpurascens (Cav. ex Lag.) Hook. & Arn.	TDF
OCHNACEAE	
Ouratea mexicana (Bonpl.) Engl.	TSF
ONAGRACEAE	
Lopezia semeiandra Plitmann, P.H. Raven & Breedlove	TSF
Ludwigia octovalvis (Jacq.) P.H. Raven	TDF, RV
OPILIACEAE	
Agonandra sp.	TDF
OROBANCHACEAE (includes Scrophulariaceae, in part)	
Buchnera pusilla Kunth	TDF, OW, EG
Melasma physalodes (D. Don) Melch.	TDF
OXALIDACEAE	
Oxalis corniculata L.	OW
Oxalis jacquiniana Kunth	TDF
PAPAVERACEAE	
Argemone ochroleuca Sweet	TDF
Bocconia arborea S. Wats.	TDF, RV

PASSIFLORACEAE	
Passiflora bryonioides Kunth	TDF
Passiflora filipes Benth.	TDF
Passiflora mexicana Juss.	TDF
Turnera coerulea DC.	OW
Turnera ulmifolia L.	OW
PHRYMACEAE (includes Scrophulariaceae, in part)	
Erythranthe floribunda (Douglas ex Lindl.) G.L. Nesom	TDF
PHYTOLACCACEAE	
Petiveria alliacea L.	TSF, RV
Rivina humilis L.	TDF
PICRAMNIACEAE	
Alvaradoa amorphoides Liebm.	TDF
Picramnia antidesma Sw.	TSF
PIPERACEAE	
Peperomia sp.	TSF
Piper amalago L.	TSF
Piper brachypus Trel.	TSF
Piper dilatatum Rich.	TDF, TSF
Piper jaliscanum S. Wats.	TSF
Piper karwinskianum (Kunth) Kunth ex C. DC.	TSF
Piper novogaliciamum Bornst.	TDF
Piper rosei C. DC.	TSF
PLANTAGINACEAE (includes Scrophulariaceae, in part)	
Mecardonia procumbens (Mill.) Small	TDF, RV
Russelia elongata Carlson	TDF
Russelia furfuracea Brandegee	TDF, TSF, OW
Russelia tetraptera S.F. Blake	TDF
Scoparia dulcis L.	TDF
Stemodia durantifolia (L.) Sw.	TDF, TSF
Stemodia pusilla Benth.	TDF
Stemodia verticillata (Mill.) Hassl.	TDF, RV
PLUMBAGINACEAE	
Plumbago zeylanica L.	TDF
POLEMONIACEAE	
Bonplandia geminiflora Cav.	TDF, TSF, EG
Loeselia ciliata L.	TDF
Loeselia glandulosa (Cav.) G. Don subsp *sonorae*	TDF
Loeselia involucrata G. Don	TDF
POLYGONACEAE	
Antigonon leptopus Hook. & Arn.	TDF, TSF
Polygonum sp.	TDF
Rumex sp.	TDF

PORTULACACEAE	
Portulaca oleracea L.	TDF, RV
Portulaca umbraticola Kunth	
Talinum paniculatum (Jacq.) Gaertn.	TDF
PRIMULACEAE (includes Theophrastaceae)	
Anagallis pumila Sw.	OW, EG
Ardisia revoluta Kunth	TSF
Jacquinia macrocarpa Cav. subsp. *pungens* (A. Gray) B. Ståhl	TDF, TSF
RANUNCULACEAE	
Clematis acapulcensis Hook. & Arn.	TDF, TSF
RHAMNACEAE	
Colubrina heteroneura (Griseb.) Standl.	TDF, OW
Colubrina triflora Brongn. ex G. Don	TDF
Gouania rosei Wiggins	TDF
Karwinskia humboldtiana (Schult.) Zucc.	TDF
Karwinskia latifolia Standl.	TDF
RUBIACEAE	
Arachnothryx leucophylla (Kunth) Planch.	TSF
Bouvardia longiflora (Cav.) Kunth	TSF
Bouvardia temifolia Standl.	OW
Cephalanthus salicifolius Bonpl.	RV
Chomelia barbata Standl.	TDF, EG
Chomelia protracta (Bartl. ex DC.) Standl.	TSF, OW
Crusea coccinea DC. var. *breviloba* Loes.	TSF
Crusea hispida (Mill.) B.L. Rob. var. *hispida*	TDF
Crusea parviflora Hook. & Arn.	TSF, OW
Crusea psyllioides (Kunth) W.R. Anderson	TSF
Diodia ocymifolia (Willd. ex Roem. & Schult.) Bremek	TDF, OW
Glossostipula blepharophylla (Standl.) Lorence	TDF
Guettarda filipes Standl.	TDF
Hamelia versicolor A. Gray	TDF, TSF
Hamelia xorullensis Kunth	TDF, TSF
Mitracarpus hirtus (L.) DC.	TDF
Mitracarpus linearifolius A. Rich.	OW
Mitracarpus rhadinophyllus (B.L. Rob.) L.O. Williams	OW
Oldenlandia corymbosa L.	RV
Randia aculeata L. var. *aculeata*	TDF
Randia armata (Sw.) DC. subsp. *armata*	TSF
Randia echinocarpa DC.	TDF
Randia induta Standl.	TDF
Randia laevigata Standl.	TDF, EG
Randia malacocarpa Standl.	TDF
Randia monantha Benth.	TDF
Randia tetracantha (Cav.) DC.	TDF, TSF
Randia thurberi S. Wats.	TDF
Richardia scabra L.	TDF, OW
Spermacoce confusa Rendle	TDF

Spermacoce densiflora (DC.) Alain	OW
Spermacoce ovalifolia (Mart. & Gal.) Hemsl.	TDF
Spermacoce prostrata Aubl.	TDF
Spermacoce suaveolens (G. Mey.) Kuntze	OW
Spermacoce verticillata L.	TDF, OW
Tessiera lithospermoides DC	TDF
RUTACEAE	
Casimiroa edulis La Llave & Lex.	TDF
Zanthoxylum arborescens Rose	TDF
Zanthoxylum fagara (L.) Sarg.	TDF, EG
SALICACEAE	
Casearia arguta Kunth	TDF, RV
Casearia corymbosa Kunth	TDF
Xylosma flexuosa (Kunth) Hemsl.	TDF
Salix taxifolia Kunth	RV
SANTALACEAE (includes Viscaceae)	
Phoradendron quadrangulare (Kunth) Griseb.	TDF
SAPINDACEAE	
Cupania dentata DC.	TSF
Paullinia cf. *fuscescens* Kunth	TDF, TSF
Paullinia sessiliflora Radlk.	TDF
Sapindus saponaria L.	TSF, RV
Serjania mexicana (L.) Willd.	TSF
SAPOTACEAE	
Sideroxylon persimile (Hemsl.) T.D. Penn. subsp. *subsessiliflorum* (Hemsl.) T.D. Penn.	TSF, RV
SCROPHULARIACEAE	
Buddleja sessiliflora Kunth	TDF
Capraria frutescens (Mill.) Britt	TDF
Pogostoma saxifragifolia (Schltdl. & Cham.) Schrad.	TDF
SOLANACEAE	
Capsicum annuum L.	TDF
Datura discolor Bernh.	TDF
Jaltomata procumbens (Cav.) J.L. Gentry	TDF
Nicotiana tabacum L.	RV
Physalis cordata Mill.	RV
Physalis hederifolia A. Gray	TDF
Physalis leptophylla B.L. Rob. & Greenm.	TDF
Physalis pruinosa L.	TDF
Physalis pubescens L.	TDF
Physalis sordida Fernald	TDF
**Siphaulax glabra* Raf. [new name for *Nicotiana glauca* Graham]	TDF
Solanum adscendens Sendtn.	TDF
Solanum americanum Mill.	TDF

Solanum candidum Lindl.	TDF
Solanum erianthum D. Don	TDF
Solanum ferrugineum Jacq.	TDF
Solanum grayi Rose var. *grayi*	TDF, RV
Solanum hazenii Britton	TDF, OW
Solanum lanceolatum Cav.	TDF
Solanum lycopersicum L. Escapada de cultivo	TSF, OW
Solanum refractum Hook. & Arn.	TDF
STEGNOSPERMATACEAE	
Stegnosperma cubense A. Rich.	TDF
URTICACEAE	
Cecropia mexicana Hemsl.	TSF, RV
Pilea hyalina Fenzl	TDF, OW, EG
Pilea microphylla (L.) Liebm.	TDF
Urera caracasana (Jacq.) Gaudich. ex Griseb.	TDF, TSF
VERBENACEAE	
Citharexylum berlandieri B.L. Rob.	TDF
Lantana camara L.	TDF, EG
Lantana hispida Kunth	TDF
Lippia umbellata Cav.	TDF
Priva lappulacea (L.) Pers.	TDF
VIOLACEAE	
Hybanthus attenuatus (Humb. & Bonpl. ex Willd.) Schulze-Menz	TDF
VITACEAE	
Cissus microcarpa Vahl	OW
Cissus tiliacea Kunth	TDF
Cissus verticillata (L.) Nicolson & C.E. Jarvis subsp. *verticillata*	TDF
ZYGOPHYLLACEAE	
Kallstroemia hirsutissima Vail	TDF
MONOCOTYLEDONEAE	
AMARYLLIDACEAE	
Hymenocallis sonorensis Standl.	TSF, RV
ARACEAE	
Anthurium nizandense Matuda	TDF, TSF
Philodendron warszewiczii K. Koch & C.D. Bouché	TSF
Xanthosoma mexicanum Liebm.	TDF, TSF
Xanthosoma robustum Schott	TDF, TSF
ARECACEAE	
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	TSF, OW

ASPARAGACEAE (includes Agavaceae, Liliaceae)	
Agave americana L.	OW
Agave angustifolia Haw. var. *rubescens* (Salm-Dyck) Gentry	OW
Agave impressa Gentry	OW
Agave ornithobroma Gentry	OW
Agave vilmoriniana A. Berger	TDF
Bessera elegans Schult. f.	OW
Manfreda jaliscana Rose	OW, EG
BROMELIACEAE	
Aechmea bracteata (Sw.) Griseb. var. *pacifica* Beutelsp.	TSF
Bromelia plumieri E. Morren [new name for *Bromelia karatas* L.]	TDF, TSF
Pitcairnia palmeri S. Wats.	TDF
Tillandsia capitata Griseb.	TDF
Tillandsia caput-medusae E. Morren	TDF, EG
Tillandsia caput-medusae E. Morren x *T. mazatlanensis* Rauh	TDF
Tillandsia fasciculata Sw.	TSF
Tillandsia ionantha Planch.	TDF, EG
Tillandsia recurvata (L.) L.	TDF
Tillandsia schiedeana Steud.	TDF, EG
COMMELINACEAE	
Callisia filiformis (Mart. & Gal.) D.R. Hunt	TDF
Callisia monandra (Sw.) Schult. & Schult. f.	TDF, EG
Commelina diffusa Burm. f.	TDF
Commelina erecta L.	TDF
Tinantia longipedunculata Standl. & Steyerm.	TDF
Tinantia macrophylla S. Wats.	TDF
COSTACEAE	
Costus sp.	TSF
CYPERACEAE	
Bulbostylis vestita (Kunth) C.B. Clarke	OW
Cyperus amabilis Vahl	OW, EG
Cyperus camus J. Presl & C. Presl	TDF, RV
Cyperus compressus L.	TDF, RV
Cyperus dentoniae G.C. Tucker	OW
Cyperus entrerianus Boeck.	TSF, RV
Cyperus fugax Liebm.	TDF
Cyperus haspan L.	OW
Cyperus iria L.	TDF, RV
Cyperus ischnos Schltdl.	OW
Cyperus mutisii (Kunth) Andersson	OW
Cyperus rotundus L.	TDF
Cyperus surinamensis Rottb.	TDF, RV
Cyperus tenerrimus J. Presl & C. Presl	TDF
Dichromena linkii J.F. Macbr. [new name for *Rhynchospora tenuis* Willd. ex Link]	OW
Fimbristylis annua (All.) Roem. & Schult.	TDF
Fimbristylis decipiens Kral	TDF

Fimbristylis dichotoma (L.) Vahl	OW
Killinga odorata Vahl	OW
Rhynchospora contracta (Nees) J. Raynal	TSF
DIOSCOREACEAE	
Dioscorea convolvulacea Schltdl. & Cham.	TDF
MARANTACEAE	
Calathea atropurpurea Matuda	TSF
Maranta arundinacea L.	TDF
ORCHIDACEAE	
Barkeria barkeriola Rchb. f.	TDF, TSF
Bletia roezlii Rchb. f.	TDF
Clowesia dodsoniana Ag. León	TSF
Encyclia adenocarpa (La Llave & Lex.) Schltr.	TSF, OW
Epidendrum cilioccidentale Hágsater & L. Sánchez	TSF
Habenaria lizbethae R. González & Cuevas Figueroa	OW
Habenaria novemfida Lindl.	TSF, OW
Trichocentrum cebolleta (Jacq.) M.W. Chase & N.H. Williams	TDF, TSF
POACEAE	
Acroceras zizanioides (Kunth) Dandy	TDF
Anthephora hermaphrodita (L.) Kuntze	TDF, EG
Aristida adscensionis L.	OW
Aristida appressa Vasey	TDF
Aristida capillacea Lam.	OW
Aristida gibbosa (Nees) Kunth	OW
Aristida jorullensis Kunth	TDF, OW, EG
Aristida ternipes Cav. var. *ternipes*	TDF, OW
Axonopus compressus (Sw.) P. Beauv.	TDF, RV
**Bothriochloa pertusa* (L.) A. Camus	TSF
Bouteloua repens (Kunth) Scribn. & Merr.	TDF, EG
**Chloris barbata* Sw.	OW
Chusquea cf. simpliciflora Munro	OW,EG
**Cynodon dactylon* (L.) Pers.	TDF
**Dactyloctenium aegyptium* (L.) Willd.	TDF
Dendrocalamopsis oldhamii (Munro) Keng f.	TDF
Diectomis fastigiata (Sw.) P. Beauv.	TDF
Digitaria argillacea (Hitchc. & Chase) Fernald	OW
**Digitaria bicornis* (Lam.) Roem. & Schult.	TDF, OW
Digitaria ciliaris (Retz.) Koeler	TDF, OW, EG
**Donax arundinaceus* P. Beauv. [new name for *Arundo donax* L.]	TDF, RV
**Echinochloa colona* (L.) Link	TDF, OW
**Echinochloa crus-galli* (L.) P. Beauv.	TDF
**Eleusine indica* (L.) Gaertn.	TDF, TSF, RV
**Eragrostis ciliaris* (L.) R. Br.	TDF
Eragrostis maypurensis (Kunth) Steud.	TDF, TSF, OW
Eragrostis pectinacea (Michx.) Nees var. *miserrima* (E. Fourn.) J. Reeder	OW
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	OW

**Hackelochloa granularis* (L.) Kuntze	OW
Heteropogon melanocarpus (Ell.) Benth.	TDF
Hilaria ciliata (Scribn.) Nash	TDF, EG
Lasiacis nigra Davidse	TDF, EG
Lasiacis procerrima (Hack.) Hitchc.	TDF, EG
Lasiacis ruscifolia (Kunth) Hitchc.	TDF, EG
Leptochloa panicea (Retz.) Ohwi var. *brachiata* (Steud.) N. Snow	TDF, RV
**Melinis repens* (Willd.) Ziska subsp. *repens*	OW
Muhlenbergia scoparia Vasey	TDF, OW
Muhlenbergia speciosa Vasey	TDF, OW
Muhlenbergia tenella (Kunth) Trin.	TDF, TSF
Muhlenbergia tenuissima (J. Presl) Kunth	TDF, EG
Olyra latifolia L.	TDF
Oplismenus burmannii (Retz.) P. Beauv. var. *nudicaulis* (Vasey) McVaugh	TDF, EG
Oplismenus compositus (L.) P. Beauv. var. *rariflorus* (J. Presl) U. Scholz	TDF, EG
Otatea acuminata (Munro) C.E. Calderón & Soderstr.	TDF, TSF
Panicum cf. *ghiesbreghtii* E. Fourn.	TDF
Panicum hirticaule J. Presl var. *hirticaule*	TDF, RV
Panicum hirticaule J. Presl var. *verrucosum* Zuloaga & Morrone	TDF
Panicum laxum Sw.	TSF
Panicum trichoides Sw.	TDF, TSF, OW
Paspalum clavuliferum C. Wright	OW
Paspalum conjugatum P.J. Bergius	TSF
Paspalum convexum Humb. & Bonpl. ex Flüggé	OW
Paspalum langei (E. Fourn.) Nash	TDF, RV
Paspalum plicatulum Michx.	OW
**Pennisetum ciliare* (L.) Link	TDF
**Pennisetum polystachion* (L.) Schult. subsp. *setosum* (Sw.) Brunken	TDF
Schedonorus arundinaceus (Schreb.) Dumort.	TDF, RV
Schizachyrium sanguineum (Retz.) Alston var. *hirtiflorum* (Nees) S.L. Hatch	TDF
Setaria longipila E. Fourn.	TDF
Setaria macrostachya Kunth	TDF, RV
**Sorghum halepense* (L.) Pers.	TDF, RV
Trachypogon secundus (J. Presl) Scribn.	OW
Tripsacum dactyloides (L.) L.	TDF
Tristachya avenacea (J. Presl) Scribn. & Merr.	OW
Urochloa distachya (L.) T.Q. Nguyen	TDF
Urochloa fusca (Sw.) B.F. Hansen & Wunderlin	TDF, RV

ACKNOWLEDGEMENTS

We are very grateful to all the specialists who helped identify the La Guásima plants: F. Almeda (IBUG), C. and W.R. Anderson (MICH), G. Andrade (UNAM), D.F. Austin† (ARIZ), M. Bauer (ARIZ), A. Bornstein (SEMO), S. Boyd (RSA), B. Boyle (ARIZ), K. Burt-Utley (UNO), E. Carranza (IEB), M. Costea (WLU), T. Croat (MO), T.F. Daniel (CAS), A. Delgado Salinas (MEXU), M.A. Dimmitt (ASDM), R.S. Felger (ARIZ), M. Fishbein (HPSU, OSU), G. Flores (MEXU), H. Flores (MEXU), M. Frohlich (KEW), P.A. Fryxell† (RSA), S. Gama (MEXU), S.A. Graham (MO), R. Grether González (MEXU), R.L. Hartman (RM), C. Gómez Hinostrosa (MEXU), M. González

Elizondo (CIIDIR), S. González Elizondo (CIIDIR), D.R. Hansen (TEX), J. Henrickson (TEX), H.M. Hernández (MEXU), P.D. Jenkins (ARIZ), H. Kennedy (MO), J. Kuijt (LEA), L.R. Landrum (ASU), J. Lombardi (HRCB), D.H. Lorence (PTBG), E.J. Lott (TEX), H. Luther† (FTG), E. Martínez (MEXU), S. McMahon (ARIZ), M. Martínez (QMEX), A. McDonald (ARIZ), G. Nesom (Fort Worth), P.M. Peterson (US), J.M. Porter (RSA), J. Pringle (HAM), P.R. Ramírez (CUCBA-UDG), L. Rico Arce (MEXU), A. Rodríguez (IBUG), G.A. Salazar (MEXU), M. Sousa S. (MEXU), R. Spellenberg (NMC), O. Téllez Valdés (IZTA), L. Torres-Colín (MEXU), R. Torres (MEXU), G.C. Tucker (EIUe), C.H. Ramos (MEXU), C.G.† and J.R. Reeder† (ARIZ), Salywon (DES), V.W. Steinmann (IEB), B.L. Turner (TEX), R. Vega (UAS), S. Zumaya (UNAM), G. Yatskievych (MO) and D.A. Yetman (UAZ-SwC). We also thank the members of La Comunidad La Guásima for their invaluable assistance in the field and CIAD, CONANP, CECyT, CONSELVA and CONAFOR for providing financial support. M. Gómez-Pérez kindly created the map of La Guásima.

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RANGE EXTENSION AND FIRST RECORD OF *CASTILLEJA CHAMBERSII* (OROBANCHACEAE) FOR THE STATE OF WASHINGTON

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ABSTRACT

A recent collection of *Castilleja chambersii* J.M. Egger & Meinke from Pacific Co., Washington, is documented and illustrated. This collection represents both a northward range extension and a first occurrence for this species in the state of Washington.

In the early 1970's, noted Oregon botanist Kenton L. Chambers explored extensively in the Coast Range of Clatsop Co., Oregon, with an emphasis on the several volcanic peaks representing the highest elevations in this older range (Chambers 1973, 1974). During these studies, Chambers noted the presence of an undescribed *Castilleja* species on exposed basalt rocks near the summits of two of the peaks, Onion Peak and Sugarloaf Mountain. The identity of these plants remained largely unexplored until the late 1990's, when Robert J. Meinke and I independently began to study Chamber's specimens and located a third population near the summit of Angora Peak, a basaltic summit ca. 4.0 km south of Onion Peak. Subsequently, we formally described *Castilleja chambersii* J.M. Egger & Meinke, based on a collection from Angora Peak (Egger & Meinke 1999).

In more recent years, several local botanists in Clatsop County, including Michael Patterson and Kathleen Sayce, spent considerable time looking for additional populations of *Castilleja chambersii*, as have employees of several agencies, timberland companies, conservation groups, and amateur botanists. Patterson, in particular, has contributed to a better understanding of the geographical extent and the population numbers on Onion and Angora Peaks and Sugarloaf Mountain. I've also returned to Clatsop County on several occasions to observe the known populations and to attempt to locate and verify some of the 10 additional populations of *C. chambersii* reported by Buechling and Tobalske (2011). However, Patterson, Sayce, and I have been unable to verify any additional populations in Clatsop County or in adjacent Tillamook Co., Oregon. All sites searched based on the Buechling and Tobalske study have contained only the widespread and somewhat similar species, *C. hispida* Benth., and all sites are at lower elevations than those on the three peaks known to host *C. chambersii*. Moreover, Buechling (pers. comm. 2011) confirmed to me that no voucher specimens, photographs, or GPS readings were collected for their study, and they had not consistently attempted to distinguish *C. hispida* from *C. chambersii* in their field identifications. It now appears likely that the Oregon distribution of *C. chambersii* is limited to the three peaks vouchered thus far. Our research has also determined that the largest populations of *C. chambersii* are found scattered over several sites on the upper portions of Onion Peak, while the populations on Angora Peak and Sugarloaf Mountain are considerably smaller and more restricted, especially on Sugarloaf, where only a single site with a small number of plants has been located.

However, in June 2015, Weyerhaeuser Company forester Kristi Tausch located and photographed live, vigorous specimens of *Castilleja chambersii* in a still-moist basalt seep on company lands on a relatively high elevation ridge in the Coast Range of the state of Washington (Fig. 1). These photos were eventually forwarded to me, and in early July 2015, I accompanied Tausch, Patterson,

Sayce, Laura Six, a Weyerhauser plant ecologist, and Nancy Peckman on a visit to two of the sub-populations located by Tausch, from which I collected the following voucher.

Washington. Pacific Co.: Coast Range, eastern Willapa Hills, upper W slope of unnamed ridge system above the headwaters of the Little East Fork of the Naselle River to the NW and of the West Fork of the Gray's River to the SE, T11N, R7E, Sect. 5, NE1/4, crevices and ledges in a seasonally seeping, basaltic rock face, 702 m, 7 Jul 2015, *Egger 1544* (WTU). The plant and associated collection obtained are shown in Figs. 2-4.

This collection is the first vouchered occurrence of *Castilleja chambersii* in the state of Washington and extends its known range to the north-northeast by about 70 km. Thus far, *C. chambersii* is known in Washington from five small sub-populations, all within a kilometer of each other along the same ridge system and at elevations ranging from about 610-715 m. This is very similar to its elevational range in Oregon, 632-950 m. In both states the vast majority of the plants occur between 680-900 m elevation. The Pacific County populations occur further from the coast, about 21 km from Gray's Bay near the mouth of the Columbia River and 27 km from the outer coastline, while the populations in Oregon range in distance from the coast between 3.9 km on Angora Peak and 8.7 km on Sugarloaf Mountain. The habitat of *C. chambersii* populations in Washington is closely similar to the Oregon populations, with most plants in both areas found in and around seeps with a basalt substrate in thin turf or in rocky crevices or benches of similar slope and aspect. One small sub-population was found on a relatively flat, gravelly ridge top at a seemingly more xeric site, but this is very atypical for this species. The formations on which the Oregon plants occur are Miocene flood basalts, while those of the Willapa Hills in Washington are uplifted Eocene seafloor basalts about twice the age of the former (Sayce 2010 and pers. comm. 2015). Apparently suitable habitat for *C. chambersii* appears to be relatively extensive in this part of Pacific County, and further fieldwork on seeping, rocky slopes in the correct elevational range may well uncover additional populations.

ACKNOWLEDGEMENTS

I thank Maria Yousoufian (WTU) for imaging the herbarium specimen. My deep gratitude is also extended to Laura Six for arranging our visit onto Weyerhaeuser timberland and especially to Kristi Tausch for helping us relocate some of the plants she originally discovered in the field. Mike Patterson and Douglas Ray provided invaluable assistance in my study of *Castilleja chambersii* in Oregon. I also thank Kathleen Sayce for very useful comments on an earlier draft. [Corrections to the figure captions were made 2 Dec 2015.]

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Fig. 1. *Castilleja chambersii*, Coast Range, Pacific Co., Washington, 16 Jun 2015. Plants in typical condition, with seeping moisture still present on this date. Also note the secondary lobes on many of the primary bract lobes, an important character for this species. Photo by Kristi Tausch.

Fig. 2. *Castilleja chambersii* (*Egger1544*, WTU) Coast Range, Pacific Co., Washington, 7 Jul 2015. Plants with many aborted flowers due to severe drought of early summer 2015. Photo by Mark Egger.

HERBARIUM OF
UNIVERSITY OF WASHINGTON
Castilleja chambersii J.M. Egger & Meinke
Family Orobanchaceae
7 Jul 2015
Location Coast Range, near summit of ridge system above headwaters of Little East Fork of the Naselle River.
Jurisdiction Weyerhauser Corporation
County Pacific
State WA
Country
Elevation ca. 2300 ft.
Crevices and ledges in igneous rock face in seepy
Color mostly red to reddish-orange bracts, some faded to dull purplish or pale white.
Notes Plants affected by severe drought conditions, with many inflorescences remaining seedless. Uncommon and scattered.
Mark Egger
1544
Distribution WTU
Photo? yes

Fig. 3. *Castilleja chambersii* (*Egger1544,* WTU), Coast Range, Pacific Co., Washington, 7 Jul 2015. First collection for this species from the state of Washington.

Fig. 4. *Castilleja chambersii* (*Egger1544,* WTU), Coast Range, Pacific Co., Washington, 7 Jul 2015. Cropped specimens.

Lebkuecher, J., K. Baker, M. Butts, K. Downey, M. Grimmett, M. Lingerfelt, R. Rickard, J. Rongholt, L. Schnorr, J. Shelton, A. Smith, J. White, and D. Winters. 2015. Evaluation of the ecological status of a stream in middle Tennessee using periphyton characteristics. Phytoneuron 2015-65: 1–7. Published 23 November 2015. ISSN 2153 733X

EVALUATION OF THE ECOLOGICAL STATUS OF A STREAM IN MIDDLE TENNESSEE USING PERIPHYTON CHARACTERISTICS

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ABSTRACT

The upper reach of Big McAdoo Creek in the Lower Cumberland River Watershed in Middle Tennessee is listed as unimpaired by nutrient enrichment by the Tennessee Department of Environment and Conservation and the United States Environmental Protection Agency. The primary objective of this research was to determine if the reach should remain listed as unimpaired. Water quality was evaluated by examining concentration of soluble reactive phosphorous, characteristics of periphyton, and the composition and structure of the diatom assemblage. An oligotrophic concentration of soluble reactive phosphorous of the water and mesotrophic concentrations of photoautotrophic periphyton indicate the stream site sampled was not impacted by nutrient enrichment. Oligotrophic to mesotrophic values for the Siltation Index, Organic Pollution Index, and Pollution Tolerance Index for the diatom assemblage indicate the assemblage was not negatively impacted by siltation, high concentrations of dissolved organics, or nutrient enrichment, respectively. The results indicate the upper reach of Big McAdoo Creek should have its water-quality status remain as unimpaired.

Knowledge of the effects of nutrient concentration on the composition and structure of photoautotrophic periphyton is essential to understand the impact of eutrophication on shallow lotic systems. Nutrient enrichment and sediments from nonpoint sources are most responsible for the biological impairment of United States waters (Irvine & Murphy 2009). Assessments of nutrient and sediment pollution are prerequisites to developing watershed management plans to protect aquatic ecosystems (Smucker & Vis 2009). Biological monitoring is essential to characterize and quantify the influences of water quality. Periodic water sampling for chemical analyses alone may not reveal the impact of nonpoint-source pollution because pollutants from nonpoint sources often enter waterways in pulses. In addition, chemical analyses do not reveal the impacts of pollution on biological integrity (Taylor et al. 2007).

Photoautotrophic periphyton are the most important primary producers in the majority of wadeable streams (Lambert & Steinman 1997). Nutrient enrichment of streams changes photoautotrophic periphyton characteristics and affects whole-stream ecological relationships. The composition, biomass, and physiological status of photoautotrophic periphyton are excellent indicators of water quality and are used universally to follow changes in aquatic environments (Eaton et al. 2005). High concentrations of chlorophyll *a* as a measurement of the biomass of photoautotrophic periphyton is a hallmark of eutrophication (Khan & Ansari 2005). Because chlorophyll-*a* concentration is influenced by many abiotic and biotic characters of a stream reach, measurements of chlorophyll-*a* concentration alone may not be adequate to demonstrate impairment by nutrient enrichment (Kurle & Cardinale 2011).

Diatoms are the focus of most studies characterizing impacts of eutrophication on periphyton composition because more autecological information exists for diatoms relative to other algae (Smucker & Vis 2013). Information from the composition of diatoms can be used to support proposed restoration and conservation policies because diatom assemblages in impaired water often reflect the nature of impairment (Smucker & Vis 2009). Evaluation of diatom composition is a standardized protocol for monitoring changes of water quality in many European countries and states including Oklahoma, Montana, Kentucky, and Texas (Stevenson et al. 2008).

Big McAdoo Creek is a major tributary of the Lower Cumberland River Watershed and joins the Cumberland River approximately 20 km south of Clarksville, Tennessee. The Lower Cumberland River Watershed is in the Western Pennyroyal Karst Level IV Ecoregion. The geologic base of the watershed is Mississippian-age limestone and includes some chert, shale, siltstone, sandstone, and dolomite. The soils are a thin loess mantle, highly erodible, and very fertile (Baskin et al. 1997). Forests are Western Mesophytic and consist largely of *Quercus* and *Carya* species (Baskin et al. 1997). The watershed encompasses approximately 2,338 square miles and has an estimated population of 155,000 people (TNCT 2015). Over 50% of the watershed is used to produce agriculture products including tobacco, corn, soybean, and livestock (TDEC 2012). The cumulative effects of erosion, agricultural runoff, livestock access to streams, and poorly functioning sewage systems result in poor quality water in the lower reaches of all of the major tributaries in the watershed. The upper reach of Big McAdoo Creek is listed as unimpaired by nutrient enrichment by the Tennessee Department of Environment and Conservation and the United States Environmental Protection Agency, whereas the lower reach is listed as impaired (TDEC 2012). The primary objective of this research was to determine if the upper reach of Big McAdoo Creek should remain listed as unimpaired. We used multiple approaches to evaluate the ecological status of Big McAdoo Creek, including determinations of soluble reactive phosphorous concentration in water samples, evaluations of periphyton biomass and physiological status, and analyses of the structure of the diatom assemblage.

Methods

Periphyton and water were sampled at the lower end of the upper reach of Big McAdoo Creek 100 m downstream of the creek crossing at Hwy 12, 30 km south of Clarksville, Tennessee, on 16 Sep 2015. Two transects from the waterlines of opposing banks, 10 m apart, were established at the sampling site. Transect widths and stream depths at 1/3 intervals of each transect were determined. Stream velocity was determined as the time required for a density-neutral object to travel 10 m downstream. Stream discharge was calculated as: Discharge = Width Depth Velocity 0.9 (Robins & Crawford 1954). A water sample was collected midstream, 5 cm below the surface, to determine the concentration of soluble reactive phosphorous using a Lachat QuickChem 8000 Flow Injection Analyzer (Lachat Instruments, Loveland, Colorado).

Six midstream plots in the 10-m reach were established with 0.25 m^2 wire frames. The fractions of stones designated as very coarse gravel or larger (considered stable substrate) and coarse gravel or smaller (considered unstable substrate) in each plot were recorded. Two cobbles nearest the plot center were removed. One cobble was used for determination of periphyton dry weight, determinations of pigment concentrations, and ash-free periphyton dry weight. One cobble was used to evaluate diatom composition. One sample of unstable substrate from each plot was removed with a core sampler for determinations of pigment concentrations associated with unstable substrate.

Laboratory methods for measurements of ash-free periphyton dry weight and concentrations of periphyton chlorophyll (chl) *a* and pheophytin (pheo) *a* are described in Eaton et al. (2005). The surface area of cobble from which periphyton was removed was calculated by covering the upper surface with aluminum foil, weighing the foil, and extrapolating weight to surface area (Hauer & Lamberti 2006). The autotrophic index (AI) was calculated using the equation of Crossy and LaPoint

(1988): AI = [Ash-free periphyton dry weight (g/m^2)]/[chlorophyll *a* (g/m^2)]. Identification of diatoms and calculation of diatom indices followed the methods described in KDOW (2002) and Lebkuecher et al. (2015).

Results and Discussion

Stream site morphological characteristics were determined to provide detail of the abiotic characteristics of the sampling site (Table 1). Stable substrate for periphyton growth (cobble and very coarse gravel) comprises approximately 1/3 of the benthic environment which is typical for the heterogeneous stream bottoms of mid-order streams in Middle Tennessee (Lebkuecher et al. 2015).

Table 1. Abiotic characteristics of the stream site sampled in Big McAdoo Creek.

Assay	Mean ± SE
Width (m)	6.5 ± 0.2
Depth (m)	0.19 ± 0.02
Velocity (m/s)	1.0 ± 0.0
Discharge (m^3/s)	0.11 ± 0.00
Percent benthic substrate	
Stable substrate (cobble + very coarse gravel)	34 ± 8
Unstable substrate (substrate smaller than very coarse gravel)	66 ± 9

The concentration of soluble reactive phosphorous of the water (Table 2) was in the range indicative of an oligotrophic to mesotrophic environment (Dodds et al. 1998), however, nutrient concentration of water is often a poor indicator of trophic state. For example, eutrophic environments with excessive concentrations of algae often have very low water phosphorous concentrations due to high phosphorous demand. Periphyton biomass, estimated as the concentration of chl *a* (mg/m^2 stream bottom), at the sampling site (Table 2) is typical of periphyton biomass in other wadeable streams in Tennessee moderately impacted by nonpoint-source pollution (Lebkuecher et al. 2000). The biomass of photoautotrophic periphyton associated with cobble (considered stable substrate) was approximately double that of the biomass associated with course gravel, sand and silt (Table 2). This result supports the conclusion that stable substrate typically supports a greater periphyton biomass relative to unstable substrate (Myers et al. 2007).

Table 2. Concentrations of soluble reactive phosphorous and characteristics of periphyton sampled from Big McAdoo Creek.

Assay	Mean + SE
Soluble reactive phosphorous (mg/L)	0.02
Chl *a* (mg/m^2 stream bottom)	35.5 ± 2.0
Chl *a* (mg/m^2 cobble)	56.6 ± 12.2
Chl *a* (mg/m^2 coarse gravel, sand, silt)	28.3 ± 2.8
Pheo *a* (mg/m^2 cobble)	1.7 ± 0.8
Ash-free periphyton (g/m^2 cobble)	3.5 ± 0.6
Autotrophic Index	67 ± 9

Measurements of the concentration of benthic pheophytin (pheo) *a* reveal the health of photoautotrophic periphyton. Chl *a* is degraded to pheo *a* as photoautotrophic periphyton senesce, hence high concentrations of pheo *a* indicate poor physiological condition. The low concentration of pheo *a* relative to chl *a* (Table 2) indicates the photoautotrophic periphyton were in excellent physiological condition (Eaton et al. 2005). This result suggests the absence of chemical pollutants such as herbicides that adversely affect the health of photoautotrophic periphyton.

Organic pollution results from erosion of organic soil, input of manure or sewage, and overgrowth of algae due to nutrient enrichment (Van Dam et al. 1994). An increase of organic debris can change several biotic characteristics of aquatic environments. Excessive concentrations of decay byproducts such as ammonia and hydrogen sulfide may be harmful to aquatic organisms. The autotrophic index (AI) is the ratio of periphyton biomass (g dry wt/m^2) to photoautotrophic-periphyton biomass (g chl *a*/m^2) and is affected by the concentration of organics (Vannote et al. 1980). AI values typically range from 30 to 300; larger values indicate heterotrophic dominance associated with high concentrations of dissolved organics (Torres-Ruiz et al. 2007). The low AI value of the Big McAdoo site sampled (Table 2) indicates that organic pollution did not impact the structure of the periphyton community.

Forty-two diatom taxa in 17 genera were identified from cobble sampled at the lower end of the upper reach of Big McAdoo Creek (Table 3). The three most abundant diatom taxa were *Achnanthidium rivulare* Potapova and Ponander (28.8 %), *Gomphonema pumilum* (Grun.) Reichardt and Lange-Bert. (18.0 %), and *Achnanthidium minutissimum* (Kütz.) Czarn. (17.8 %). The values for the Shannon Diversity Index and evenness for the diatom assemblage (Table 4) are similar to other diatom assemblages sampled in the ecoregion (Lebkuecher et al. 2013). Despite the high diversity of diatom assemblages in general, dominance by a few taxa is typical and lowers the values for evenness and Shannon Diversity Index.

The Siltation Index (SI) is the percentage of motile diatoms (Bahls 1993). Motile diatoms are able to avoid being buried and are tolerant of sedimentation. SI values $\geq$ 50 denote severely degraded habitat by excessive sediments. The low SI value for the diatom assemblage (Table 4) indicates the reach sampled was not sediment impaired. The organic pollution Index (OPI) is the percentage of taxa tolerant of organic pollution (Kelly 1998). OPI values $\leq$ 20 indicate the absence of significant organic pollution, 21–40 infers some organic pollution present, and values > 40 suggest a significant influence of organic pollution. The low OPI value for the diatom assemblage at the Big McAdoo site (Table 4) indicates the absence of organic pollution. This conclusion is supported by the low value for the Autotrophic Index (Table 2).

The Pollution Tolerance Index of diatom assemblages (PTI) reveals the impact of nutrient concentration on the diatom assemblage and the trophic state of water. The PTI is calculated using the relative abundance and an eutrophication-tolerance value for each taxon of the assemblage. The eutrophication-tolerance value for a taxon is determined from autecological information and ranges from 1 to 4 (KDOW 2002). Taxa very tolerant of eutrophic conditions and more abundant in eutrophic habitats are assigned an eutrophication-tolerance value of 1. Taxa very intolerant of eutrophic conditions are assigned an eutrophication-tolerance value of 4. The PTI ranges from 1 to 4 and values $\leq$ 2.6 indicate a diatom assemblage which is negatively impacted by eutrophication (Lebkuecher et al. 2011). The high PTI value for the diatom assemblage at the Big McAdoo site (2.9; Table 4) indicates the assemblage is not impaired by nutrient enrichment.

Evaluations of the periphyton community at the upper reach of Big McAdoo Creek indicate the site is not markedly impacted by nutrient enrichment. This conclusion is supported by the low concentration of soluble reactive phosphorous of the water, the mesotrophic concentrations of photoautotrophic-periphyton biomass, and the value of the Pollution Tolerance Index of the diatom assemblage. The structure of the diatom assemblage also indicates the assemblage is not impacted by siltation nor dissolved organics. Our results suggest the status of the upper reach of Big McAdoo Creek should remain listed as unimpaired.

Table 3. Diatom taxa and percent taxon composition sampled from cobble in Big McAdoo Creek listed in alphabetical order.

Taxon name	Percent composition
Achnanthidium deflexa Reimer	6.8
Achnanthidium minutissimum (Kütz.) Czarn.	17.8
Achnanthidium rivulare Potapova and Ponander	28.8
Achnanthidium sp.	0.5
Amphora minutissima W. Sm.	0.3
Amphora ovalis (Kütz.) Kütz.	0.8
Amphora perpusilla Grun.	0.3
Amphora veneta Kütz.	0.3
Cocconeis placentula Ehrenb.	0.8
Cocconeis placentula var. euglypta Ehrenb.	0.5
Cymbella affinis Kütz.	2.3
Cymbella tumida (Bréb.) Van Heurck.	1.8
Diploneis elliptica (Kütz.) Cleve	0.3
Encyonema minutum (Hilse) Mann	0.5
Encyonema silesiacum (Bleisch) Mann	0.3
Gomphonema angustatum (Kütz.) Rabenh.	0.8
Gomphonema brasiliense Grun.	1.3
Gomphonema minutum Ag.	1.0
Gomphonema parvulum (Kütz.) Kütz.	0.3
Gomphonema pumilum (Grun.) Reichardt and Lange-Bert.	18.0
Gomphonema sp.	0.8
Gyrosigma acuminatum (Kütz.) Rabenh.	0.3
Karayeva clevei (Grun.) Round and Bukht.	0.3
Melosira varians Ag.	0.3
Navicula capitatoradiata Germ.	0.3
Navicula cryptotenella Lange-Bert.	1.0
Navicula lanceolata (Ag.) Ehrenb.	0.3
Navicula minima Grun.	2.3
Navicula subminuscula Mang.	2.5
Navicula subrotundata Hust.	2.5
Navicula viridula (Kütz.) Ehrenb.	0.5
Nitzchia amphibia Grun.	0.3
Nitzschia dissipata (Kütz.) Grun.	0.3
Nitzschia frustulum (Kütz.) Grun.	0.8
Nitzschia inconspicua Grun.	0.5
Nitzschia linearis (Ag.) W. Sm.	0.3
Nitzschia sinuata var. tabellaria Grun.	1.3
Nitzchia sp.	0.8
Psammothidium curtissimum (Carter) Aboal	0.8
Rhoicosphenia curvata (Kütz.) Grun.	0.3
Sellaphora seminulum (Grun.) D. G. Mann	1.3
Stephanodiscus sp.	0.3

Table 4. Metrics and indices of the diatom assemblage sampled in Big McAdoo Creek. The index scale is the range of values possible from very good to very poor quality water.

Index	Index scale	Index value
Taxa richness		42
Genus richness		17
Shannon Diversity Index		2.5
Evenness	1 - 0	0.7
Siltation Index	0 - 100	13
Organic Pollution Index	0 - 100	12
Pollution Tolerance Index	4 - 1	2.9

ACKNOWLEDGEMENTS

The research was funded by the Department of Biology at Austin Peay State University, Clarksville, Tennessee.

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A FORMAL ANALYSIS OF PHYLOGENETIC TERMINOLOGY: TOWARDS A RECONSIDERATION OF THE CURRENT PARADIGM IN SYSTEMATICS

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ABSTRACT

BACKGROUND: For too many years the practice of systematics has been impeded by profound disagreements about the very foundations of this discipline, that is to say the type of information that should or should not be incorporated into a proper classification of life. Two main schools of systematics, both recognizing evolution, oppose each other: cladism states that the classification should only reflect the branching order of the lineages on the tree of life whereas evolutionism states that the length of the branches, that is the degree of modification, should also be taken into account so as to reflect macroevolutionary leaps. The first one forbids the exclusion of any descendant from a group that contain its ancestors, while the second one explicitly requires that the descendants too much different from their ancestors must be classified separately. Moreover, both schools often use the same words, such as "monophyly," to designate different ideas. This prevents proper communication between the proponents of either side. Consequently, the research in phylogenetics is globally erratic and the taxonomic classification is highly unstable.

RESULTS: I rigorously define the terms which designate the phyletic relationships and explore their properties through use of graph theory. I criticize a similar work (Kwok 2011) that was unable to properly catch these notions. This leads me to provide three independent arguments — one historical, one utilitarian, and one morphosemantic — in order to retain the original Haeckelian meaning of the term "monophyly" rather than the redefined Hennigian one. I identify some polysemy regarding the term "clade," and that is why I define two new words, "holoclady" and "heteroclady," to contrast respectively with "holophyly" and "heterophyly." I also show that a strictly holocladic or holophyletic classification advocated by cladists is formally impossible. I therefore review and criticize the philosophical postulates subtending such an illogical paradigm. I show that cladism is part of a more general philosophical movement named structuralism, which is mainly characterized by anti-realism and a metaphysical way of thinking. I identify the biologically unrealistic assumptions on which cladism is based and argue that they have been empirically falsified. I therefore defend the use of paraphyletic groups in the scientific classification of life and review the main arguments that have been opposed to this solution. Some of them, such as anthropocentrism or the lack of an objective manner to determine paraphyletic groups, are grossly outdated, while others simply rest upon the difficulty in conceptualizing emergent phenomena.

CONCLUSION: Since clades are still useful for methodological reasons, I offer a compromise that should make possible the coexistence of the two main opposing schools of systematics by eliminating competition between clades and taxa for the same names. I propose therefore that in a future revision, the *BioCode* should approve a dual system by recognizing both a "phyletic arrangement" made of clades and a "phylogenetic classification" made of taxa.

"We often discussed his notions on objective reality. I recall that during one walk Einstein suddenly stopped, turned to me and asked whether I really believed that the moon exists only when I look at it." (Pais 1979)

CONTENT

Introduction 2
1. Genealogical Networks 3
2. Common Ancestors and Monophyly 6
3. Ancestral Groups and Monophyletic Unions 10
4. Concepts Derived from Monophyly 12
5. Partitioning the Different Types of Groups 14
6. Phylogeny and Phylogenetic Classification 17
7. Notion of Clade 19
8. Cladograms, Cladification and Cladonomy 26
9. Establishment of the Current Paradigm 30
10. Analysis of the Cladist Doctrine 33
10.1. Structuralist Influence 33
10.2. Paraphyletic Species 34
10.3. Virtual Ancestors 35
10.4. Uniformitarianism and Punctualism 35
10.5. Idealist Drift 37
10.6. Pitfall of Nominalism 38
10.7. Evolutionist Solution 39
Conclusion 42
Acknowledgments 44
Annexe: Mathematical Proofs 44
Literature cited 50

INTRODUCTION

Systematics has been marked for many decades by vigorous methodological debates concerning the classification of life, especially regarding the status of paraphyletic groups (Mayr 1974; Hennig 1975). These debates have annoyingly never reached a true consensus (Mayr & Bock 2002; Goldenfeld & Woese 2007). These disputes about the topological properties of taxa were interspersed with major terminological controversies (Ashlock 1971; Nelson 1971; Ashlock 1972; Nelson 1973) which plagued the discussions, even today blurring practice and progress in this discipline (Brummitt 1997; Cavalier-Smith 1998; Mayr 1998; Woese 1998; Ghiselin 2004; Brummitt 2006; Hörandl 2007; Podani 2010b; Zander 2011; Schmidt-Lebuhn 2012; Schmidt-Lebuhn 2014; Stuessy & Hörandl 2014; Brummitt 2014).

Although both opposing sides have firmly stood their ground over the years, one quickly took the ascendancy over the other in both practice (Dumoulin & Ollivier 2013) and teaching (Lecointre et al. 2008) of systematics throughout the world. This relatively recent paradigm, which is called "cladism", insists on the purely "genealogical" pattern that a natural classification of living things must have. According to it, taxa must be delimited through a unique formal principle: the inclusion of all descendants of the last common ancestor of its members (Hennig 1966). Cladism probably owes its success in part to the attractiveness of this imperative which is supposed to facilitate the decision making process and free the classification of life from all forms of subjectivity (Hennig 1966; Hennig 1975; Schmidt-Lebuhn 2012). Cladism unfortunately appeared in conjunction with a new method of resolving phyletic relationships: cladistics (Hennig 1950; Hennig 1966). Always presenting themselves as inseparably linked to each other, up to using the same word of "cladistics" to refer to one or the other (Ashlock 1974; Mayr 1974; Hennig 1975), cladism directly benefited from

the popularity and effectiveness of this method. The opposing position, evolutionism, has therefore been described as "traditional" or "classical" to emphasize its purported obsolescence. Rejecting cladism would therefore be a synonym of rejecting cladistics, and therefore rejecting progress (Hennig 1975). This claim does not give a faithful image of modern evolutionary systematics which has fully integrated the contributions of cladistics and of subsequent molecular phylogenetic techniques to give birth to many fertile theories (Cavalier-Smith 2002a; Cavalier-Smith 2010a; Zander 2013).

The purpose of this paper is primarily to rigorously analyse, with the aid of an appropriate mathematical formalism, the notions of systematics in order to objectively solve the terminological dispute which has been plaguing the theoretical discussions for half a century. On the basis of this common vocabulary, I intend on the one hand to reveal some logical inconsistencies arising from cladism, and on the other hand to decipher the philosophical foundations that underlie them. This will allow me to resolutely advocate abandoning sterile cladism and rallying evolutionary systematics. However, I will also propose a short-term workable compromise which would allow the establishment of a "peaceful coexistence," or even cooperation, between practitioners of cladonomy and those of taxonomy.

1. GENEALOGICAL NETWORKS

It is not the first time that one tries to formally define the phylogenetic concepts. Hennig himself modelled the succession of generations in sexual populations through directed acyclic graphs (Hennig 1966). However Kwok (2011) pointed out that "[w]here mathematical definitions have been presented […], the properties of such concepts have not been explored". This fact greatly limited their usefulness. Such an exploration was recently attempted (Kwok 2011), but it failed to adequately describe some key concepts because of the choice of bad axioms as I shall demonstrate. Curiously, the author nonetheless came to the same conclusion as I, concerning the impossibility of consistently reconciling the Linnaean hierarchy with cladism, but without realizing all the implications. In the course of this work, I will therefore emphasize the reasons justifying the better adequacy of my model to the biological reality. I will also insist on the logical consequences that prove the unreasonableness of the cladist imperative and of the assumptions that constitute its framework of thinking. Since this paper focuses on definitions and terminology, and does not have the ambition to unveil novel mathematical properties of directed acyclic graphs, I have relegated in the annexe the proofs of the various lemmas and theorems.

Definition 1.1 *(Genealogical Network)* A genealogical network G is a pair (X, p) where X is a non-empty finite set and p is a binary relation on X such that p is acyclic, i.e. for every sequence x_1, x_2, …, x_n of elements of X, if $n \geq 2$ and if for every i, $1 \leq i \leq n-1$, $(x_i, x_{i+1}) \in p$, then $x_1 \neq x_n$.

This definition of a genealogical network matches the one of a *directed acyclic graph* (or DAG), a common mathematical object in graph theory. As a consequence of this definition, it can be trivially drawn that $(x, x) \notin p$ for every $x \in X$. The set X embodies a population and the pair $(x_1, x_2) \in p$ should be read as "x_1 is a parent of x_2" (see Figure 1).

Definition 1.2 *(Lineage)* Let there be a genealogical network $G = (X, p)$. A sequence x_1, x_2, …, x_n of elements of X is called a lineage if $n = 1$, or else if $n \geq 2$ and $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq n-1$.

In particular, for any $x \in X$, the sequence consisting of the single element x is a lineage. Intuitively, a lineage is thus a line of descendants without gaps.

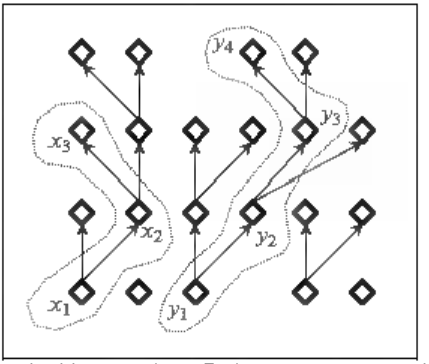

Figure 1. A genealogical network without mergings. Each square represents an individual. The whole of the squares constitute the set X. The whole of the arrows represents the binary relation p defined on the set X (every arrow is an element of p). For example, x_1 and y_4 are individuals. The individual x_1 is a parent of x_2 (see Definition 1.1). The sequence x_1, x_2, x_3 is a lineage (see Definition 1.2) and x_1 is an ancestor of x_3 (see Definition 1.3), but x_3 is not an ancestor of x_1 (see Lemma 1.6). The individual y_1 is an ancestor of y_2 which is itself an ancestor of y_4, therefore y_1 is an ancestor of y_4 (see Lemma 1.5).

Definition 1.3 *(Ancestor)* Let there be a genealogical network $G = (X, p)$ and $x \in X$. An individual $a \in X$ is an ancestor of x if and only if there exists a lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$ and $x_n = x$.

Observation 1.4 Let there be a genealogical network $G = (X, p)$, whatever $x \in X$, x is an ancestor of x.

This observation, although counter-intuitive, is a trivial consequence of Definition 1.2 and Definition 1.3. Kwok (2011) correctly noted that this property greatly facilitates the formulation of many propositions thereafter. This fact has been longstandingly remarked, for example by Ashlock (1972) who noticed, following Tuomikoski (1967), that "Hennig's definition of monophyly—all descendants of the most recent common ancestor—specifically excludes the stem ancestor of the group, *since the stem ancestor cannot be descendant of itself* [my emphasis]." The choice we make therefore simplifies our wording without falling into such a trivial trap. The following lemmas collect some well-known facts about DAGs.

Lemma 1.5 *(Transitivity)* Let there be a genealogical network $G = (X, p)$ and three distinct individuals $a, b, c \in X$. If a is an ancestor of b and b is an ancestor of c then a is an ancestor of c.

This is of course true in the special case where $(b, c) \in p$, i.e. $k = n + 1$.

Lemma 1.6 *(Non-Reciprocity)* Let there be a genealogical network $G = (X, p)$ and $x, y \in X$ such that $x \neq y$, if y is an ancestor of x then x is not an ancestor of y.

Lemma 1.7 *(Fragmentation of a Lineage)* Let there be a genealogical network $G = (X, p)$, g a non-empty subset of X, and the individuals $a \in g$ and $x \notin g$. If a is an ancestor of x, then for every lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$ and $x_n = x$, it exists a certain i, $1 \leq i \leq n - 1$, such that $x_i \in g$ and $x_{i+1} \notin g$.

Figure 2 exemplifies Lemma 1.7. Following the everyday terminology of biologists, I will thereafter use the term "group" to refer to any non-empty subset g of X.

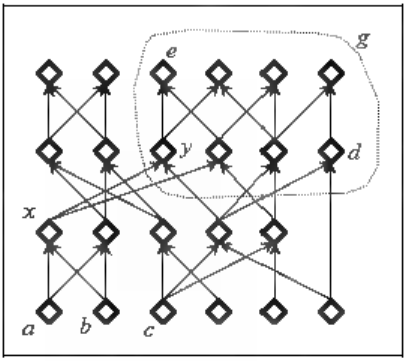

Figure 2. A genealogical network with mergings. In such a network, an individual x could be descended from parents a and b for example. A parent, like c, can reproduce with different partners. Some individuals, like d, can be descended from parents of different generations. In this example ■ is an ancestor of e which belongs to an arbitrary group g. The individual a therefore belongs to a group g', complementary to g in X, to which e does not belong. By Lemma 1.7 it exists therefore an individual x not belonging to g which is a parent of an individual y belonging to g.

Definition 1.8 *(Subnetwork)* Let there be a genealogical network $G = (X, p)$ and a group $g \subset X$. Let us say that $G' = (X', p')$ is a subnetwork of G generated by g if and only if $X' = g$ and $p' = p \cap g^2$.

This definition allows us to trivially convert a group into a subnetwork, thus permitting us to simply extend group properties to networks.

Definition 1.9 *(Group without Mergings)* Let there be a genealogical network $G = (X, p)$ and a group $g \subset X$. Let us say that g is a group without mergings if and only if no organism in g has multiple parents.

Observation 1.10 *(Network without Mergings)* Let there be a genealogical network $G = (X, p)$, a group $g \subset X$ and G' a subnetwork generated by g. If g is a group without mergings then G' can also be called a network without mergings.

The converse of this definition does not hold inasmuch as an element of a network without mergings can accept several parents provided that they are not members of it. A network without mergings can be called a "tree". It is not necessarily dichotomous. It is however the most common case because of the binary fission of prokaryotes or the eukaryotic mitosis. The absence of mergings of different lineages implies the absence of sexuality, the absence of hybridization and the absence of symbiogenesis.

Lemma 1.11 *(Uniqueness of a Lineage)* Let there be a genealogical network $G = (X, p)$ without mergings and the individuals $a, x \in X$. If a is an ancestor of x then it does exist only one lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$ and $x_n = x$.

Theorem 1.12 *(Relation between Ancestors)* Let there be a genealogical network $G = (X, p)$ without mergings and the individuals $a, b, x, y \in X$. If a is an ancestor of x and y, and b is an ancestor of x but not of y, then a is ancestor of b.

The properties expressed by Lemma 1.11 and Theorem 1.12 are depicted in Figure 3. These preliminary definitions being established, we now have the necessary materials to tackle the problem of monophyly.

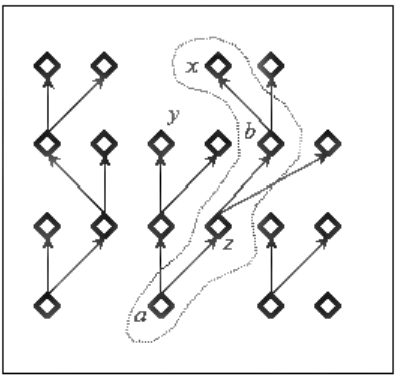

Figure 3. Relations between the ancestors of a unique lineage in a network without mergings. Since this genealogical network is without mergings and a is an ancestor of x, then by Lemma 1.11 there exists only one lineage linking these two individuals: a, z, b, x. In the same way, since a is an ancestor of both x and y whereas b is an ancestor of x only, we conclude by Theorem 2.12 that a is an ancestor of b. If we define $g = \{x, y\}$ then a is a common ancestor of g (see Definition 2.1).

2. COMMON ANCESTORS AND MONOPHYLY

It is remarkable how such a central concept like monophyly in a discipline like systematics fails to be unanimously defined. This paradox may be due in part to the fact that despite awkward definitions, the claim that a group must be monophyletic in order to be considered a taxon, i.e. a natural group, was already consensual before cladism has imposed itself. We found for example in Simpson (1961) a wording which seems today rather obscure: "monophyly is the derivation of a taxon through one or more lineages from one immediately ancestral taxon of the same or lower rank".

Taking advantage of these awkwardnesses, it was easier to make cladism acceptable by subtly redefining the concept of monophyly rather than defining a new concept that would have had to impose itself by replacing the former. Thus, Hennig (1950; 1966) just had to claim to formulate a more precise definition while expropriating it (Ashlock 1971; Ashlock 1972; Mayr 1974; Mayr & Bock 2002). Today the most widespread definitions are similar to those of Hennig. But If we go back to the roots, the word "monophyletic" was originally coined by Haeckel (1866) to refer to the theory that all extant organisms are descended from a single common ancestor, i.e. that life has appeared only once. Its use was later extended by its inventor himself to describe the taxa (or "phyla" in his terminology) of a natural classification of life:

"*Unter Phylon verstehen wir stets die Gesammtheit aller blutsverwandten Organismen, die von einer gemeinsamen typischen Stammform abstammen.*" (Haeckel 1877)

By phylon we invariably understand the totality of the organisms related by blood, descended from a common *typical* ancestor [my translation and my emphasis].

The adjective "typical" allows Haeckel to exclude divergent descendants who do not share the ancestral body plan, thus creating valid monophyletic groups like Reptilia (the reptiles) whereas some descendants like Aves (the birds) are deliberately removed (Haeckel 1868). The addition of this very word in the third edition of his *Anthropogenie* demonstrates the lucidity of Haeckel regarding the inadequacy and awkwardness of the definition he had originally given in the first edition of his book (Haeckel 1874). As we can clearly see, the concept of monophyly is centered on the ancestor, and more precisely the unique ancestor (which justifies the choice of μόνος "alone" in its etymology), not on the descendants! Thus, in his analysis of Haeckel's terminology, Dayrat (2003) notes: "In the two words 'monophyletic' and 'polyphyletic,' [the etymon *phylon*] clearly refers to the concept of stem."

The historical fact that Hennig had actually redefined the concept of monophyly by significantly straying from its Haeckelian use seems today to be tacitly accepted by some cladists (Vanderlaan et al. 2013). We shall see later other reasons not to retain the Hennigian meaning (see Section 4 and Section 5). But first let us begin by defining hereinbelow the notion of common ancestry, and then use it so as to rigorously formulate the concept of monophyly *sensu* Haeckel.

Definition 2.1 *(Common Ancestor)* Let there be a group g and an individual $a \in X$, a is a common ancestor of g if and only if for every $x \in g$, a is an ancestor x.

In particular, and as a consequence of Observation 1.4, for every $x \in X$, x is a trivial common ancestor of the group $\{x\}$.

Definition 2.2 *(Most Recent Common Ancestor)* Let there be a group g and $a \in X$ a common ancestor of g. The individual a is a most recent common ancestor of g if and only if for every a' common ancestor of g, either a is not an ancestor of a', or else $a = a'$.

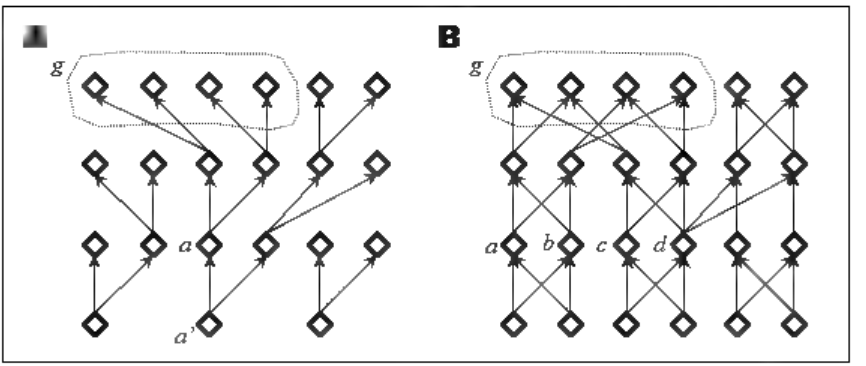

Figure 4. Common ancestors in networks without or with mergings. (A) a' is a common ancestor of g but is not a most recent common ancestor of g because it is itself an ancestor of a which is also a common ancestor of g. The individual a is on the contrary a most recent common ancestor (cenancestor) of g because it does not exist descendants of ■ that are common ancestors of g. (B) In the framework of sexual reproduction, a, b, c and d are equally in this example the four most recent common ancestors (cenancestors) of g.

A most recent common ancestor does neither necessarily belong to g, nor is necessarily unique, as for example in the case of sexual reproduction (see Figure 4). A most recent common ancestor is sometimes called a cenancestor in evolutionary biology, with a prefix "cen-" derived from both κοινός "recent" and κοινός "common". The concept of cenancestor was originally used in the more restricted meaning of last universal common ancestor (Fitch & Upper 1987; Doolittle & Brown

1994; Cavalier-Smith 2001), but it is as such a too narrowly defined term for an ordinary use in everyday systematics, i.e. outside the very specific field of the origin of life. It can be indeed observed that in other contexts the few authors that use this term tend to talk about the cenancestor of either this or that group (Cavalier-Smith 2002a). The others use acronyms (Koonin 2010; Valas & Bourne 2011) such as LECA (last eukaryotic common ancestor), LACA (last archaebacterial common ancestor), etc. or else give some special names to these common ancestors, like "urbilateria" (Moroz 2012; Nilsson 2013) which derive from the taxon's name Bilateria and from the German prefix "ur-" which marks an origin. This lack of homogeneity in scientific literature could be easily resolved by the regular use of the word cenancestor in the broad sense: it has the advantages of being simple, transparent and readily adaptable to any situation.

Definition 2.3 *(Monophyletic Group)* Let there be a group g, g is said to be monophyletic if and only if there exists $a \in g$ such that a is a common ancestor of g.

Lemma 2.4 *(Uniqueness of the Included Common Ancestor)* For any monophyletic group g, there exists only one common ancestor a of g such that $a \in g$. This unique included common ancestor is also a most recent common ancestor (cenancestor) of g.

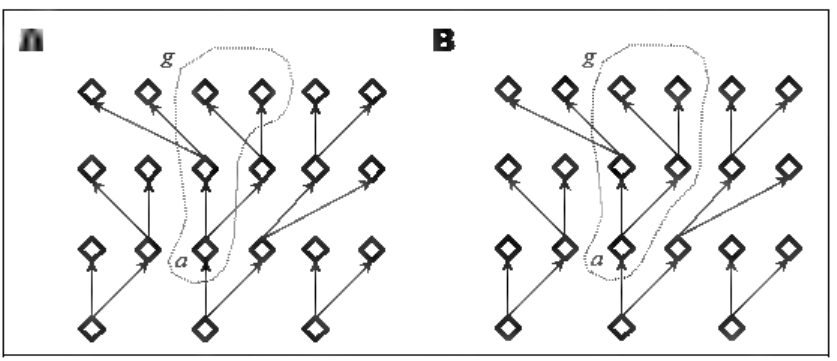

Figure 5. Discontinuous and continuous monophyletic groups. (A) The group g is monophyletic because a, which belongs to g, is an ancestor of all the members of g. (B) The group g is monophyletic and continuous because for all the members of g there exists at least one lineage linking them to a such that all the members of these lineages belong to g.

This first definition of monophyly means that a group can only be considered as such if it is formed of descendants of one of its members. The problem that this simple formulation poses is that the intermediate individuals linking a cenancestor to the other members of the group are not necessarily themselves members of this very group (see Figure 5A), which is obviously at odds with the spontaneous idea that biologists have of monophyly. This logically leads us to add a condition of lineage continuity so that the properties of our formal definition match those of real biological groups studied in practice (see Figure 5B).

Definition 2.5 *(Continuous Monophyletic Group)* Let there be a monophyletic group g and a its unique included common ancestor. The group g is said to be continuous if and only if for every $x \in g$ there exists at least one lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$, $x_n = x$, and if $n > 1$ then $x_i \in g$ and $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq n-1$.

A "continuous monophyletic group" can simply be called a "continuous group". A monophyletic group that is not continuous can unequivocally be called "discontinuous". As we can see, our wording is centred on the ancestor. Conversely, Kwok (2011) focuses on descendants. He begins by defining a "descent group" as comprising a set of progenitors and all of their descendants (his Definition 3). Next, he specifies that two descent groups are "disconnected" if their intersection is the empty set (his Observation 14). This finally allows him to define a monophyletic group as being a descent group that cannot be split into two disconnected descent groups (his Definition 15).

The main flaw of his definition is not the inclusion of all the descendants of the progenitors, but the non-uniqueness of these progenitors (see Lemma 2.4). As we can see in Figure 6A the connected descent groups do not necessarily correspond to monophyletic groups by our definition since they do not always contain a unique most recent common ancestor! The goal of this author was to find out a way to link together genealogy and phylogeny. He thus started from the biased assumption that what occurs in infraspecific and supraspecific levels is fundamentally different (which we shall refute later, see Theorem 6.2). He seems to have been abused by the so-called "biological definition" of a species, i.e. as a group of interbreeding individuals. However, sexuality is only an epiphenomenon, proper to the eukaryotes alone in the entire living world. Life did have only prokaryotic asexual reproduction for at least its first two billion years of existence (Cavalier-Smith 2002b; Gross & Bhattacharya 2010; Cavalier-Smith 2010b). This led him to ignore the definitions of monophyly on which he did rely so far: "an ancestor and all of its descendants" (Barton et al. 2007). It should also be noted that the merging of two lineages is not an exclusive phenomenon of sexuality, it is found for example in hybridization between two closely related species (furthermore fairly common in plants) or in symbiogenesis between two very distant species. Although these events are rarer it would be unacceptable to exclude them from our model. Their consideration renders the shortcomings of Kwok's definition (2011) especially flagrant (see Figure 6B). Treating species like any other taxon is actually the most parsimonious solution in terms of hypotheses. The next parts of our study should enable us to move from this base taxon to higher taxa while maintaining the consistency of the already studied topological properties. The two following lemmas are very well-known properties about trees it is worth mentioning.

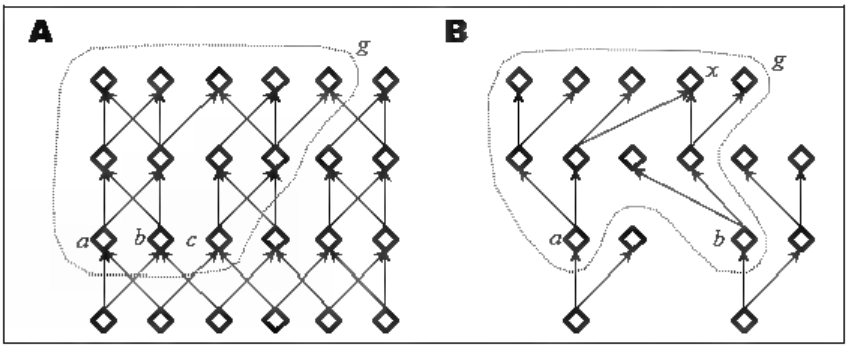

Figure 6. Descent groups. (A) The individuals *a*, *b* and *c* are the three progenitors of the connected descent group *g*. Since it does not contain a unique common ancestor, then it cannot be considered as monophyletic. (B) The individuals *a* and *b* are two progenitors of the connected descent group *g*. We can imagine for example that *a* is the most recent common ancestor of all protozoa and *b* the one of cyanobacteria, such that *x* is the one of plants. It would be of course absurd to consider the set "protozoa + cyanobacteria + plants" as monophyletic.

Lemma 2.6 *(Uniqueness of the Lineages in Continuous Groups without Mergings)* Let there be g a continuous monophyletic group defined in a genealogical network without mergings $G = (X, p)$, and the individuals a, $x \in g$ such that a is an ancestor of x. Then it does exist only one lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$ and $x_n = x$. Moreover, $x_i \in g$ for every i, $1 \leq i \leq n$.

Lemma 2.7 *(Uniqueness of the Most Recent Common Ancestor)* Let there be a genealogical network without mergings $G = (X, p)$, a group $g \subset X$ and $a \in X$ a most recent common ancestor (cenancestor) of g. Then there does not exist $a' \in X$ being a most recent common ancestor of g such that $a \neq a'$.

3. ANCESTRAL GROUPS AND MONOPHYLETIC UNIONS

We studied as a first step the relations between individuals. In order to generalize these properties to groups of individuals we must expand our definitions to group relations.

Definition 3.1 *(Ancestral Group)* Let there be g_1 and g_2 two monophyletic groups such that $g_1 \cap g_2 = \emptyset$, and a the unique included common ancestor of g_2. We can say that g_1 is an ancestral group of g_2 (or that g_1 is ancestral to g_2) if and only if there exists $x \in g_1$ such that x is an ancestor of a.

Definition 3.2 *(Directly Ancestral Group)* Let there be g_1 and g_2 two monophyletic groups such that $g_1 \cap g_2 = \emptyset$, and a the unique included common ancestor of g_2. We can say that g_1 is a directly ancestral group of g_2 (or that g_1 is directly ancestral to g_2) if and only if there exist $x \in g_1$ such that $(x, a) \in p$.

Ancestral groups are clearly analogous to ancestors of individuals (see Figure 7A). Likewise, directly ancestral groups can be regarded as equivalent to parents of individuals. Incidentally, it is not rare to find in scientific literature phrases like "sister group" or "daughter group" to characterize such relationships (see Figure 7B). Thus we can say that Reptilia is the mother group of Aves and Mammalia, which are its two daughter groups.

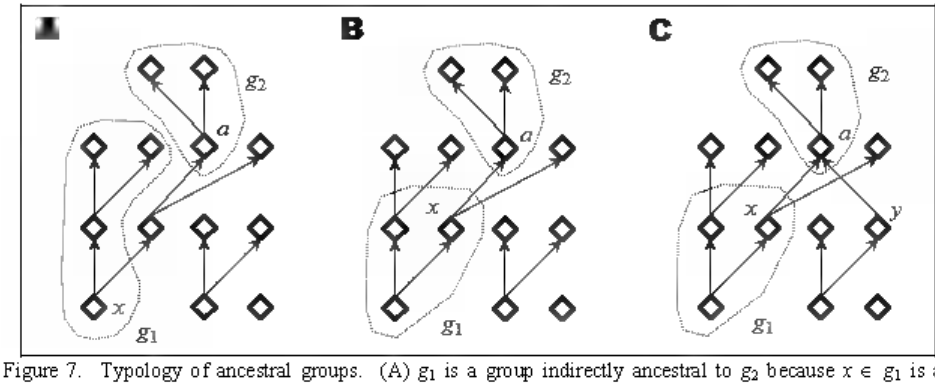

Figure 7. Typology of ancestral groups. (A) g_1 is a group indirectly ancestral to g_2 because $x \in g_1$ is an ancestor of a, itself the last included common ancestor of g_2, but there does not exist an individual of g_1 that a parent of a. (B) g_1 is here directly ancestral to g_2 because $x \in g_1$ is a parent of a; it is also a group exclusively ancestral to g_2 because all the parents of a belong to g_1. (C) g_1 is here directly but not exclusively to ancestral to g_2 because y, one the parents of a, does not belong to g_1.

Definition 3.3 *(Exclusively Ancestral Group)* Let there be g_1 and g_2 two monophyletic groups such that $g_1 \cap g_2 = \emptyset$, and a the unique included common ancestor of g_2. We can say that g_1 is an exclusively ancestral group of g_2 (or that g_1 is exclusively ancestral to g_2) if and only if for every $x \in X$, if $(x, a) \in p$ then $x \in g_1$.

In reality taxa can indeed be direct ancestors without being exclusive ancestors, as for example in the case of plants, which have two directly ancestral groups: protozoa and cyanobacteria (see for example Figure 7C).

Observation 3.4 *(Single Parenthood)* If the unique included common ancestor of g_2 does have only one parent (as for example in the case of a network without mergings) and if g_1 is directly ancestral to g_2, then we can trivially say that g_1 is exclusively ancestral to g_2.

Lemma 3.5 *(Transitivity)* Let there be three monophyletic groups g_1, g_2 and g_3. If g_1 is ancestral to g_2 and g_2 is ancestral to g_3 then g_1 is ancestral to g_3.

This lemma clearly echoes to Lemma 1.5, which demonstrates the transitivity of ancestrality between individuals.

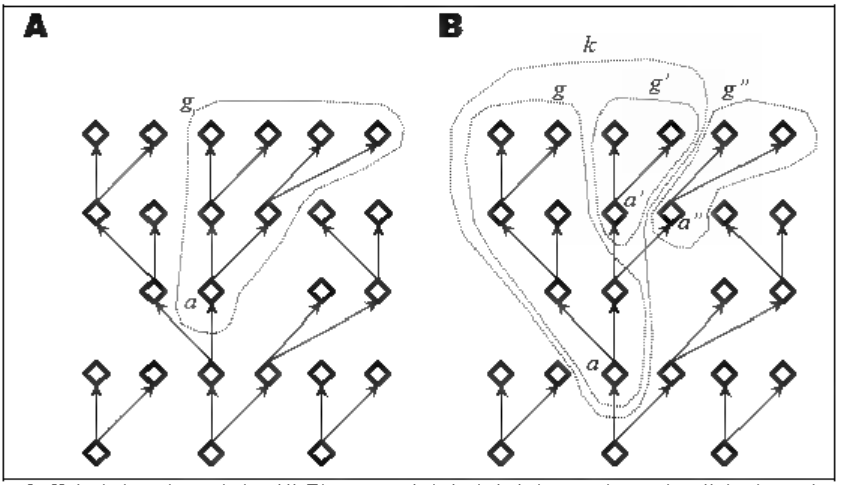

Figure 8. Holophyly and paraphyly. (A) The group *g* is holophyletic because it contains all the descendants of *a*, the included common ancestor of *g*. (B) The group *g* is paraphyletic because it does not contain all the descendants of *a*: *a'* and *a''* for example. It is however monophyletic since it contains *a*, an ancestor of all the members of *g*. The group *g'*, also monophyletic, is a group to which *g* is ancestral because ■ is an ancestor of *a'*. Thus by Theorem 3.6, the union *k* is a monophyletic group (here continuous).

Theorem 3.6 *(Monophyletic Union)* Let there be g_1 and g_2 two monophyletic groups such that $g_1 \cap g_2 = \emptyset$. The group $g = g_1 \cup g_2$ is monophyletic if and only if the group g_1 is ancestral to g_2 or else if g_2 is ancestral to g_1.

Theorem 3.7 *(Continuous Union)* Let there be g_1 and g_2 two continuous groups of G such that $g_1 \cap g_2 = \emptyset$. The group $g = g_1 \cup g_2$ is continuous if and only if the group g_1 is directly ancestral to g_2 or else if g_2 is directly ancestral to g_1.

By combination of Theorem 3.6 and Theorem 3.7, it is clear that the union of two distinct continuous groups but indirectly ancestral is a discontinuous group. Figure 8B depicts a union between two continuous groups.

4. CONCEPTS DERIVED FROM MONOPHYLY

Having firmly established the necessary foundations for our study, we can now define some derived concepts and explore their properties. The concept of paraphyly in particular is not really an issue since all authors do agree that to make one it is sufficient to remove some descendants of the cenancestor of a monophyletic group (Hennig 1966; Cavalier-Smith 1998; Mayr & Bock 2002; Barton et al. 2007).

Definition 4.1 *(Paraphyletic Group)* Let there be a group g, g is said to be paraphyletic if and only if g is monophyletic and there exists a pair $(x, y) \in p$ such that $x \in g$ and $y \notin g$.

Definition 4.2 *(Holophyletic Group)* Let there be a group g, g is said to be holophyletic if and only if g is monophyletic and there does not exist a pair $(x, y) \in p$ such that $x \in g$ and $y \notin g$.

Lemma 4.3 *(Monophyletic Alternative)* Let there be a monophyletic group g and a its cenancestor. The group g is paraphyletic if and only if there exists a certain $x \notin g$ such that a is an ancestor of x, otherwise g is holophyletic.

The topological difference between holophyly and paraphyly is depicted in Figure 8. Definition 4.1 and Definition 4.2 define these notions by referring to parenthood whereas Lemma 4.3 is a reformulation referring to ancestry. We saw in the Section 3 of this paper that there exists an historical argument in favour of rejecting the Hennigian definition of monophyly. Here we can see that this Hennigian concept can be expressed by another word: "holophyly", coined by Ashlock in order to resolve this absurd terminological controversy (Ashlock 1971; Ashlock 1972; Mayr 1974; Ashlock 1979; Mayr & Bock 2002). Surprisingly this new term, which is nevertheless logically independent of the philosophical debate between evolutionism and cladism, was firmly rejected by proponents of cladism (Nelson 1971; Nelson 1973; Hennig 1975). This lack of agreement on vocabulary had inevitably led to confusion and focused much of the discussion on the form rather than the content of the problem. It was impossible for evolutionists to abandon this word to cladists since they had no other term to account for their concept of monophyly, which combines both holophyly and paraphyly.

This is what I call the utilitarian argument: cladists can perfectly express their ideas by using "holophyly" instead of "monophyly", whereas evolutionists cannot assert their point of view without a word meaning "holophyly + paraphyly". Furthermore, such a concept is today generically useful in studies of unrooted phylogenetic trees where precisely it is *de facto* impossible to distinguish holophyly and paraphyly. This has even led to the (redundant) coinage of the new term "clan" so as to fill this gap (Wilkinson et al. 2007). Let us finally notice in support of this argument that the word "holophyly" is built from the root ὅλος "all", which makes the term both transparent and unequivocal. We will see later (see Section 5) a third and last reason to prefer our definition of monophyly.

Definition 4.4 *(Polyphyletic Group)* Let there be a group g, g is said to be polyphyletic if and only if there does not exist $a \in g$ such that a is a common ancestor of g.

Clearly, a polyphyletic group is by definition the contrary of a monophyletic group. Groups are always either monophyletic or polyphyletic, which is indeed an expected property (see Table 1).

<table>
<tr><td rowspan="2">Monophyletic</td><td rowspan="2">Continuous</td><td colspan="2">Holophyletic</td></tr>
<tr><td rowspan="2">Paraphyletic</td><td rowspan="3">Heterophyletic</td></tr>
<tr><td>Discontinuous</td></tr>
<tr><td colspan="3">Polyphyletic</td></tr>
</table>

Table 1. Logical links between phyletic relationships. A group is always either monophyletic or polyphyletic. A monophyletic group is either continuous or discontinuous. A holophyletic group is necessarily continuous whereas a paraphyletic group can be either. Finally, a heterophyletic group is either paraphyletic or polyphyletic.

Definition 4.5 *(Heterophyletic Group)* Let there be a group g and A the set of all the most recent common ancestors (cenancestors) of g. g is said to be heterophyletic if and only if for every $a \in A$, it exists $x \notin g$ such that a is an ancestor of x. If $A = \emptyset$ then g is also heterophyletic (and polyphyletic in this case).

A heterophyletic group is thus a group which does not comprise all the descendants of each and every of its cenancestors. The case $A = \emptyset$ does not concern biology much since it has long been demonstrated beyond all reasonable doubt that all extant organisms and fossils are descended from a last universal common ancestor (LUCA). This very particular case of polyphyly is mentioned only in discussions about the origin of life on Earth (since the concept of LUCA must not be confused with the very first organism) or elsewhere. The term "heterophyly" was coined only recently (Zander 2009) and its use is consequently still not very widespread despite its usefulness.

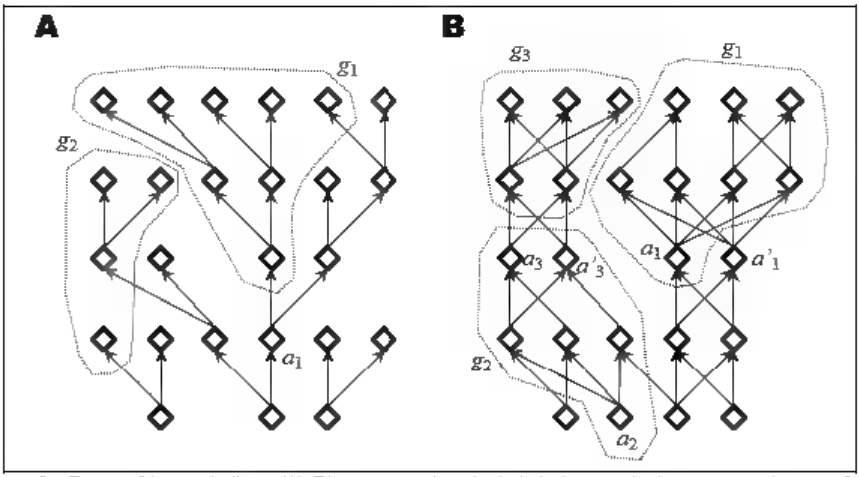

Figure 9. Types of heterophylies. (A) The group g_1 is polyphyletic because it does not contain any of the common ancestors of its members, for example a_1; the g_2 is polyphyletic because there does not even exist a common ancestor of all its members. (B) The group g_1 is not heterophyletic but holophyletic because it includes all the descendants of its cenancestor, here a_1. The group g_2 is heterophyletic because it does not include all the descendants of its cenancestor a_2; although it may seem counter-intuitive the group g_3 is also heterophyletic since it does not include any of its most recent common ancestors, a_3 or a'_3.

Lemma 4.6 Let there be a group g and $A \neq \emptyset$ the set of all the most recent common ancestors of g, g is heterophyletic if and only if g is paraphyletic or else if g is polyphyletic.

Observation 4.7 Let there be a group g and $A \neq \emptyset$ the set of the most recent common ancestors of g, g is heterophyletic if and only if g is not holophyletic.

This observation ensues from the fact that all groups are either polyphyletic or monophyletic and that all monophyletic groups are either paraphyletic or holophyletic (see Table 1). Heterophyly is depicted in Figure 9 in the context of a network with or without mergings. The main types of groups commonly encountered in scientific literature having been defined, the next parts of this paper shall consist in showing how it is possible to build a consistent Linnaean classification from this base material.

5. PARTITIONING THE DIFFERENT TYPES OF GROUPS

Taxonomy involves classifying the different organisms in disjoint sets, and the union of these sets must contain all the organisms. The use of set partitions in order to establish a model for classification of life seems therefore natural. In addition, we must join the condition of monophyly defined above.

Definition 5.1 *(Continuous Partition)* Let there be a group g, a continuous partition of g is a set $K = \{g_1, g_2, \ldots, g_n\}$ such that: firstly for every i, $1 \leq i \leq n$, $g_i \neq \emptyset$ and g_i is continuous; secondly if $n \geq 2$ then for every i, j, $1 \leq i < j \leq n$, $g_i \cap g_j = \emptyset$; and thirdly $\bigcup_{1 \leq i \leq n} g_i = g$.

A continuous partition is depicted in Figure 10.

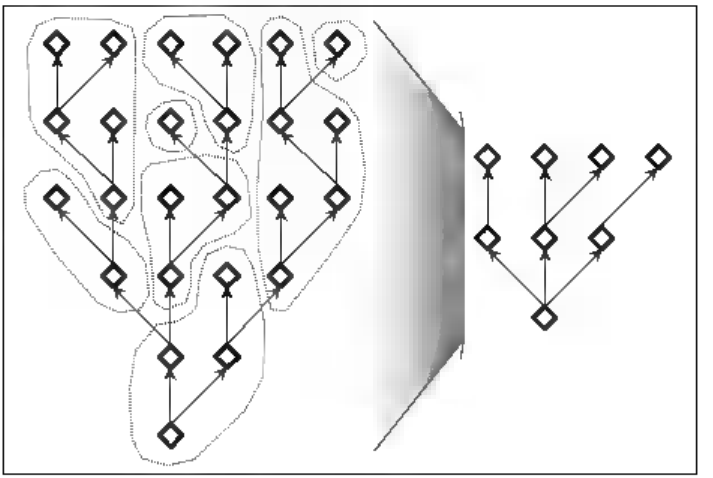

Figure 10. From a genealogical network to a phylogenetic one. The genealogical network depicted on the left is partitioned into continuous monophyletic groups (dotted lines). The relationships between individuals are thus replaced with relationships between directly ancestral groups. These groups and these relations can be depicted by a phylogenetic network (on the right) which is in fact the same mathematical object as a genealogical network (see Theorem 6.2).

Lemma 5.2 *(Existence)* It is always possible to define a continuous partition of a non-empty group. Such a partition can't have more parts than the whole group.

This means that in the limiting case every organism is just its own group. Indeed, the trivial set of all singletons is a continuous partition.

Observation 5.3 Let there be a continuous group g, the set $\{g\}$ is a trivial continuous partition of g.

Theorem 5.4 Let there be a continuous group g and $K = \{g_1, g_2, \ldots, g_n\}$ a continuous partition of g such that $n \geq 2$. It must then exist a certain i, $1 \leq i \leq n$, such that g_i is paraphyletic.

In whatever manner such a partitioning of a continuous group is handled, it is impossible to avoid the creation of paraphyletic groups. Kwok (2011) reached a very similar conclusion since he has shown that a consistent Linnaean classification though strictly holophyletic must contain only trivial monotypic groups ($n = 1$) except at the lowest rank (his Corollaries 43 to 45): we would thus have a unique species which comprises all organisms, then a unique genus composed of this sole species, then a unique family composed of this sole genus, etc. The condition $n \geq 2$ is therefore central to reveal that it is logically impossible to avoid paraphyly. This means that regardless of how it is taken, cutting branches of the tree of life automatically generates paraphyletic stems. This deduction, after all rather obvious, has been repeatedly reported (Meacham & Duncan 1987; Brummitt & Sosef 1998; Brummitt 2002; Brummitt 2003). For example Cavalier-Smith (1998) showed in the second figure of his paper that rejecting paraphyly involves not to classify some organisms. As he already stated in a previous paper:

"*It is impossible to cut up a phylogenetic tree into purely holophyletic groups: every cut generating a holophyletic branch necessarily also generates a paraphyletic stem.*" (Cavalier-Smith 1993)

This naturally led him to conclude that:

"*The dogma against paraphyletic taxa is logically incompatible with the acceptance of both evolution by descent and the goal of taxonomy as the creation of a comprehensive phylogenetic* classification of all organisms, *both extant and extinct.*" [my emphasis] (Cavalier-Smith 1998)

Not to classify all organisms at all levels is to say that for example some might be part of a family, but not part of a genus or a species, which is unacceptable. Although he stressed that his conclusion was correct, Kwok unfortunately did not drawn all the consequences from it by rejecting the principle of a purely holophyletic classification. Continuous partitions remain however a powerful tools to study the properties of different types of groups as we shall see in the rest of this paper.

Definition 5.5 *(Degree of Polyphyly)* Let there be a group g and $K = \{g_1, g_2, \ldots, g_n\}$ a continuous partition of g of cardinal n. We can say that n is the degree of polyphyly of g if there does not exist a continuous partition of g of cardinal inferior to n.

Observation 5.6 All continuous groups have a degree of polyphyly of 1.

This observation clearly derives from Observation 5.3. This leads us to notice how much the traditional definitions of monophyly (from ancient Greek μόνος "sole") and polyphyly (from πολύς "many") are consistent with the etymologies of these words. By removing paraphyletic groups from the concept of monophyly, Hennig's expropriation consequently removes certain groups which have nonetheless a degree of polyphyly of just one! Furthermore, the Definition 5.5 shows that a

polyphyletic group can easily be cut into several monophyletic groups (See Lemma 5.2). Thus, a *poly*phyly corresponds well and truly to a concatenation of several *mono*phylies, and not necessarily several *holo*phylies. This is what I name the morphosemantic argument: it is desirable for obvious logical reasons that the morphologies of these words are congruent with their semantical relationships.

In his paper Kwok (2011) also discusses these etymologies and claims he has demonstrated that a polyphyletic group is indeed the plural of a "monophyletic" (i.e. holophyletic) group. His definitions of "monophyly" and polyphyly are regrettably distorted, and his conclusion is consequently invalid. Firstly, as previously shown, his definition of "monophyly" does not require the inclusion of a common ancestor and hence doesn't properly capture this concept. Thus, many so-called "monophyletic" groups are in fact frankly polyphyletic (see Section 2 and Figure 6). Secondly, his definition of polyphyly is curiously restricted to the groups composed of *all* the descendants of their progenitors. Thus, a group like the one depicted in Figure 11A, which is patently polyphyletic for any systematician, would be considered as non-polyphyletic according to Kwok's definition! He logically concludes (his Theorem 22) that these very particular polyphyletic groups can be split into several "monophyletic" groups, which are in fact polyphyletic as well. It may be possible to see a confirmation bias in this kind of reasoning.

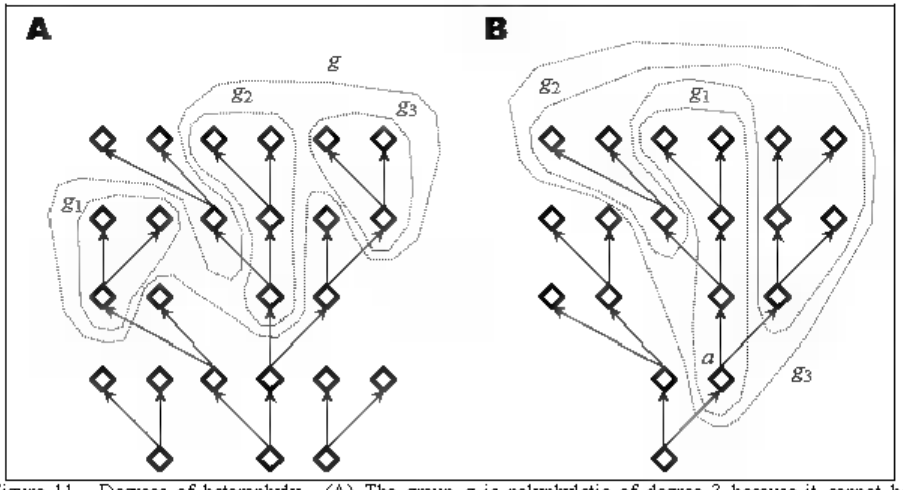

Figure 11. Degrees of heterophyly. (A) The group g is polyphyletic of degree 3 because it cannot be partitioned into less than 3 monophyletic groups, of which one is paraphyletic; this partitioning is unique. (B) The group g_1 is paraphyletic, g_3 represents the holophyletic group canonically associated to it and g_2 its complementary group; the group g_1 has a degree of paraphyly of 2 because the group g_2 has a degree of polyphyly of 2.

Theorem 5.7 *(Uniqueness)* Let there be g a group without mergings, polyphyletic of degree n, and $K = (g_1, g_2, \ldots, g_n)$ a continuous partition of g of cardinal n. Then, there does not exist any other continuous partition $K' \neq K$ of g such that $\mathrm{card}(K') = n$.

A polyphyletic group can therefore be uniquely split into a minimal number of monophyletic groups. They can be either holophyletic or paraphyletic (see Figure 11A). Of course, this theorem echoes the one of Kwok that we have just mentioned. By correcting the premises we come to a valid conclusion which reinforces our morphosemantic argument: a group arising from several origins can

be divided into several groups each of them arising from a unique origin. It is indeed in this spirit that Haeckel coined the opposition monophyletic/polyphyletic (see Section 2). Although formally independent, the morphosemantic argument and the historical one do strengthen each other.

The notion of paraphyly is often defined by opposition to holophyly (or "monophyly"). This definition is nearly always negative (some descendants are *removed*). We are nonetheless going to show that it is possible to expand the notion of paraphyly so as to make holophyly just a particular case of paraphyly.

Definition 5.8 *(Canonical Holophyletic Group)* Let a monophyletic group g et a the unique included common ancestor of g. Let us call g' the holophyletic group canonically associated to g if and only if for every $x \in X$, if a is an ancestor of x then $x \in g'$.

Definition 5.9 *(Complementary Group)* Let there be g a monophyletic group. We say that g' is the complementary group of g if and only if $g \cap g' = \emptyset$ and $g'' = g \cup g'$ is the holophyletic group canonically associated to g.

The canonical holophyletic group associated to a holophyletic group is always itself. Consequently, the complementary group of a holophyletic group is always the empty set.

Definition 5.10 *(Degree of Paraphyly)* Let there be g a monophyletic group and g' its complementary group. If g' is non-empty, then the degree of paraphyly of g is said to be the same as the degree of polyphyly of g'. If $g' = \emptyset$, the degree of paraphyly of g is logically 0.

The degree of paraphyly thus corresponds to the number of "branches", or clades, removed from the canonical holophyletic group (see Figure 11B). It is usual in scientific literature to find discussions about some taxa said to be "more or less" paraphyletic, or "more or less" polyphyletic. This "more or less" has sometimes been criticized because of the lack of a precise definition referring to such a vague notion of degree. All formal definitions of the base concepts I could find were limited simple dichotomies, sharply distinguishing holophyly from paraphyly and monophyly from polyphyly. Our study shows that it is possible to expand these notions by rigorously defining what degrees of polyphyly and paraphyly are. It is thus acceptable to define holophyly as being the property of a group having a degree of polyphyly of one and a degree of paraphyly of zero. This situation is comparable to modern physics where rest is regarded as a movement having a zero speed (as opposed to the archaic Aristotelian physics which sharply opposes rest and movement). There exists therefore a dialectal relation between monophyly and polyphyly, and also between holophyly and paraphyly (Envall 2008).

6. PHYLOGENY AND PHYLOGENETIC CLASSIFICATION

Our study has allowed us so far to form group and subgroups in our genealogical network. We have therefore finally all the necessary elements to make up a phylogenetic network as well as a phylogenetic classification.

Definition 6.1 *(Phylogenetic Network)* Let there be a genealogical network $G = (X, p)$. Let there be also X' a continuous partition of X, and p' a relation defined on X' such that $(g_1, g_2) \in p'$ for every $g_1, g_2 \in X'$, if and only if g_1 is directly ancestral to g_2. Then, the pair $G' = (X', p')$ is called a phylogenetic network.

Theorem 6.2 *(Sameness)* Every phylogenetic network is a genealogical network.

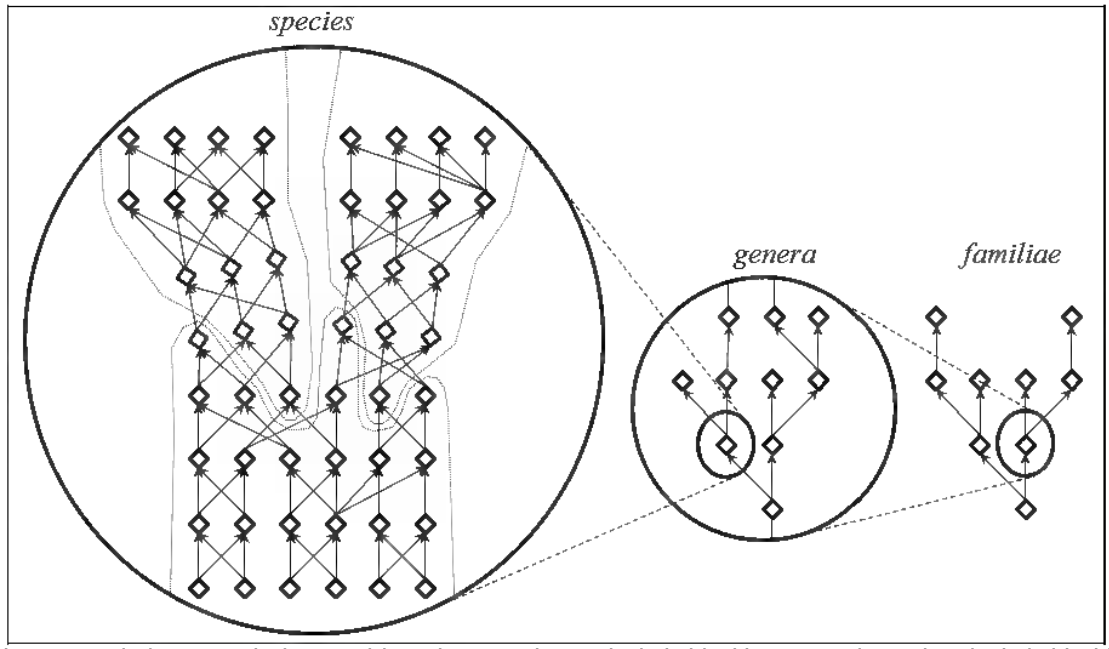

Figure 12. Phylogeny and Linnaean hierarchy. Species are included inside genera, themselves included inside families, etc.

We can deduce from this theorem that all the properties studied in genealogical networks on the scale of the relationships between individuals are also valid in phylogenetic networks on the scale of the relationships between groups (see Figure 10). This theorem is of crucial importance to the debate concerning the nature of phylogenetic trees: do their structures reflect real genealogies or else an abstract kinship? Our analysis clearly allows us to take a position in favour of the first option.

Definition 6.3 *(Linnaean Hierarchy)* Let there be a genealogical (or phylogenetic) network $G = (X, p)$. A Linnaean hierarchy is a sequence $X_1, X_2, \ldots, X_n$ such that $n \geq 2$, $X_1 = \{X\}$, and for every i, $1 \leq i \leq n-1$, X_{i+1} is the union of fixed continuous partitions of the elements of X_i. For every i, $1 \leq i \leq n$, X_i is called a taxonomic category, whereas the elements of X_i are called taxa, and finally i is the rank of these taxa.

Our definition allows us to clarify the difference between a "taxonomic category" and a "taxonomic rank", which are often confused in practice. For example Animalia is a taxon that *has* the rank of kingdom (i = "*regnum*"), but we must say that it *belongs to* the category of kingdoms (Animalia $\in X_{\text{"regnum"}}$). Thus, a category is simply a set of all the taxa that have the same rank. In practice, X is the set of all organisms and X_1 is a set containing only one taxon which contains itself all organisms. For example if $X = \{a, b, c, d, e, f\}$ then $X_1 = \{\{a, b, c, d, e, f\}\}$. A continuous partition of the unique element of X_1 may be $\{\{a, b, c\}, \{d, e, f\}\}$, therefore $X_2 = \{\{a, b, c\}, \{d, e, f\}\}$. This set contains two elements, a continuous partition of the first one may be $\{\{a, b\}, \{c\}\}$ and a continuous partition of the second one may be $\{\{d\}, \{e, f\}\}$, therefore $X_3 = \{\{a, b\}, \{c\}, \{d\}, \{e, f\}\}$, and so on. The set $\{a, b, c\}$ of X_2 may be regarded as a kingdom, while the set $\{a, b\}$ of X_3 may be regarded as a phylum (see Figure 12).

Definition 6.4 *(Taxonomic Position)* Let there be a network $G = (X, p)$ and $X_1, X_2, \ldots, X_n$ a Linnaean hierarchy on this network. The taxonomic position of a taxon t_k of rank k is a sequence $t_1, t_2, \ldots, t_k$ such that $t_1 \in X_1$ and for every i, $1 \leq i \leq k-1$, $t_{i+1} \in X_{i+1}$ and $t_{i+1} \subset t_i$. The taxonomic position of an individual is given by the smallest taxon to which it belongs, i.e. a taxon of rank n.

The taxonomic position indicates the location of a taxon in a Linnaean hierarchy. For example, the taxonomic position of the organism a is the sequence $\{a, b, c, d, e, f\}$, $\{a, b, c\}$, $\{a, b\}$, etc. As indicated in the definition above, such a classification is inclusive, i.e. made of *nested* groups. These groups are however not *embedded*: a taxon is composed of organisms, not of taxa of lower rank. Thus, we should not say that the genus *Caenorhabditis* belongs to the family Rhabditidae, but rather that it is included in it.

This classification is based on no other formal criterion that the respect of continuous monophyly. Other criteria needed to validate a given taxon are exclusively of biological nature and therefore rely on evolutionary, ecological and phenetic considerations to decide between different possible formal divisions. The name of "evolutionary classification" is thus plainly justified. As a consequence of Lemma 5.2, which specifies that a division into monophyletic groups is always possible, all individuals of a genealogical network do have a taxonomic position regardless of the complexity of the network (see Figure 12). A phylogenetic classification (in an evolutionary sense) is therefore a consistent classification scheme.

7. NOTION OF CLADE

Maybe we could blame our definitions of phyletic relationships for their lack of operationality because they refer to unknown ancestors (Nelson 1973). It is true that the labour of phylogeneticists is precisely to reconstruct the relationships of the species they study from very fragmented data. Thus the construction of a phylogenetic tree often requires going through the elaboration of a cladogram, a type of diagram depicting the genealogical relative proximity (or degree of kinship) of different sampled species. Yet it just so happens that some authors have proposed definitions of "monophyly" only by referring to topological relationships that connect the species studied in such a diagram:

"*Monophyly: a quality of a group including all species, or groups of species, assumed to be descendants of a hypothetical ancestral species.* […]" (Nelson 1971)

In this definition the most recent common ancestor (cenancestor) is explicitly excluded. When we defined monophyly and associated concepts in previous sections our goal was to represent a certain reality, whether it is accessible or not to us. Here our goal is to represent our knowledge of a certain reality. We must not confuse reality and the knowledge we have of it, that's why we have to use another term that "monophyly" to depict it.

Definition 7.1 *(Holoclady)* Let there be a genealogical or phylogenetic network $G = (X, p)$, a non-empty subset $K \subset X$ and A the set of all the common ancestors of a certain group $g \subset K$. The group g is said to be holocladic if and only if $A \neq \emptyset$ and there exists an $a \in A$ such that for every $x \in K$, if $x \notin g$ then a is not an ancestor of x. Such a common ancestor is called an exclusive common ancestor of g in K.

In the definition above, K may represent the set of all "accessible" organisms: for example all extant organisms, or else all known organisms (eventually from palaeontology), or else simply all the organisms included in a given study. The group g represents the sample under focus (see Figure 13A). A holocladic group is often simply called a "clade". The concept of clade initially referred to any monophyletic group *sensu* Haeckel (Huxley 1959), but the redefinition made by Hennig, however in the ambiguous sense of "holophyly or holoclady," is now universally accepted (Cavalier-Smith 2010a).

Having shown that genealogical and phylogenetic networks are the same, in the definition above X could be either a set of organisms or else a set of groups of organisms, in the same way as the

elements x could be either organisms or else groups of organisms. An exclusive common ancestor is not necessarily unique, as it is the case for example in sexual reproduction. All the most recent common ancestors need not to be exclusive in order for ■ group to be holocladic (see Figure 13B). By the way, an exclusive common ancestor is not always ■ most recent common ancestor (see Figure 13C). Just as we previously defined ■■ opposite term to each phyletic relationship (see Table 1), the definition of the opposite notion of ■ clade is designed in order to simplify wording in systematics' discussions.

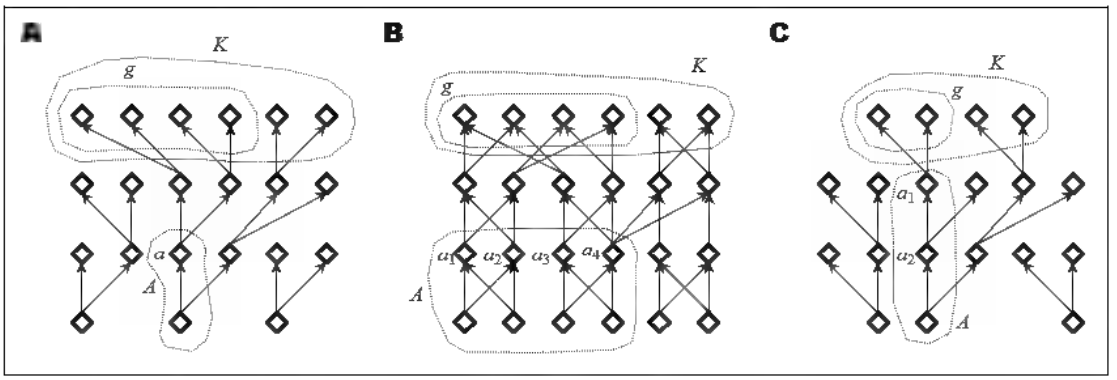

Figure 13. Holoclady and exclusive common ancestors. The set K represents the set of species included in the study, g is a group that we want to validate as a clade, A is the set of the common ancestors of g. (A) Example of a holocladic group in ■ network without mergings, a is both ■ most recent common ancestor and an exclusive common ancestor of g in K. (B) In this network with mergings, a_1, a_2 and a_3 are exclusive common ancestors of g but this is not the case for a_4 because, although it is also a most recent common ancestor of g, some of its descendants in K do not belong to g. (C) In this example a_1 and a_2 are both exclusive common ancestors of g in K but only a_1 is a most recent common ancestor of it.

Definition 7.2 *(Heteroclady)* Let there be ■ genealogical or phylogenetic network $G = (X, p)$, a non-empty subset $K \subset X$ and A the set of all common ancestors of a certain group $g \subset K$. The group g is said to be heterocladic if and only if $A \neq \emptyset$ or if for every $a \in A$ it exists ■ certain $x \in K$ such that a is an ancestor of x and $x \notin g$.

Observation 7.3 *(Potential Polyphyly)* Let there be g a holocladic or heterocladic group and A the set of all its common ancestors. The group g is polyphyletic if and only if $A \cap g = \emptyset$, otherwise it is monophyletic.

This observation comes directly from Definition 2.3 and Definition 4.4, and is clearly depicted in the three examples of Figure 13. This result seems to contradict intuition because of the very frequent confusion between the concepts of holoclady and holophyly. This confusion comes from the misleading terminology of cladists that use the same word "monophyly" to refer to both concepts. Let us notice also that the ancestors are not necessarily excluded from the studied group, since it is *a priori* impossible to know that no species is an ancestor of another one in the studied sample.

Definition 7.4 *(Canonical Holophyletic Group)* Let there be g a holocladic group defined in K on the network $G = (X, p)$, A the set of all the common ancestors of g and $a \in A$ an exclusive common ancestor of g. We call a canonical holophyletic group of g any holophyletic group g' such that a is the unique included common ancestor of g'.

Because there can be several exclusive common ancestor, there may also be several canonical holophyletic groups. This definition recalls us how much holoclady and holophyly are distinct

concepts. Although sometimes a holocladic group is itself its own holophyletic group canonically associated, the word "clade" should not be used as a synonym for "holophyletic group" because if may unnecessarily increase the confusion between holoclady and holophyly.

Lemma 7.5 If g' is a canonical holophyletic group of a clade g, then $g \subset g'$.

Definition 7.6 *(Degree of Heteroclady and Canonical Holocladic Group)* Let there be g a heterocladic group. Let there be $n \geq 1$, then it is said that the degree of heteroclady of g is inferior or equal to n if and only if it exists n holocladic groups g_i such that $g' = g \cup \bigcup_{1 \leq i \leq n} g_i$ is a holocladic group under the condition that for every i, $1 \leq i \leq n$, for every j, $1 \leq j \leq n$, with $i \neq j$, then $g_i \cap g_j = \emptyset$ and $g_i \cap g = \emptyset$. These groups are called complementary groups of g, and g' is the holocladic group canonically associated to g.

Observation 7.7 Holoclady is naturally associated to a null degree of heteroclady: there is no complementary group and $g = g'$.

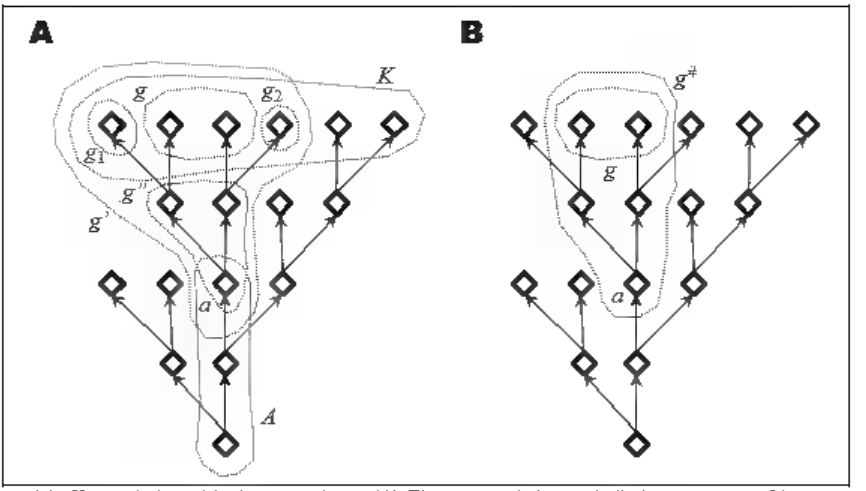

Figure 14. Heteroclady and its interpretations. (A) The group g is heterocladic because none of its common ancestors depicted by the set A is an exclusive common ancestor of its elements in the subset K. The groups g_1 and g_2 are the complementary groups of g in K because the union $g \cup g_1 \cup g_2$ is holocladic, the degree of heteroclady of g is therefore 2. The sole exclusive common ancestor of its associated holocladic group is a, which leads to the definition of g', constituted of a and all of its descendants, as the holophyletic group canonically associated to g. The group g'', constituted solely by the elements of g' absent from K, is the basal group of g. (B) The group g can be interpreted as being simply an invalid polyphyletic group or else as revealing the existence of a natural group $g^{\#}$, paraphyletic of degree 2.

A heterocladic group has no exclusive common ancestor, but it is however possible to attribute to this group a canonical holophyletic group by associating to it the one of its own canonical clade (see Figure 14A). This means that a holocladic pattern suggest the existence of a real situation of holophyly, whereas a heterocladic pattern only indicates a lack of holophyly: it is not then possible to formally decide between a real situation of paraphyly or of polyphyly (see Figure 14B). Biological arguments are thus necessary to determine if it is relevant or not to include a cenancestor of the group

in it. It is a complex decision which largely depends on our knowledge on ecology, evolutionary mechanisms, palaeontological data, etc.

This may explain in part the attractivity of an automatical method which, by rejecting any heteroclady and therefore putatively any heterophyly, covers up these difficult dilemmas in the labour of phylogeneticists, but without really resolving them… This led to the reinforcement of two opposing attitudes, equally disastrous for both stability and relevance of the classification of life. Firstly, *lumping* consists in always unifying heterocladic groups with their complementary groups, which consequently drowns homogeneous and relevant taxa inside too large and too heterogeneous groups. Secondly, *splitting* consists on the contrary in dividing heterocladic taxa in smaller holocladic groups, which consequently leads to the disjunction of similar sets. This could have led for example to an explosion of the number of "phyla" or on the contrary to the merging of many genera thus containing very different species.

To describe similar concepts to those of holoclady and heteroclady, Podani respectively coined the terms "monoclady" and "paraclady" (Podani 2009; Podani 2010a; Podani 2010b; Podani 2013). In the context of synchronic classification, i.e. a precise slice of time, he states that "a group is monocladistic if it includes all terminals of a given clade" (Podani 2009). As a consequence, a "monocladistic" pattern suggests the existence of a situation of holophyly and *a priori* excludes paraphyly (however we will see that this must be nuanced). Since "monoclady" implies the rejection of this type of monophyly, the replacement of this misleading term by "holoclady" seems rather wise. Moreover this modification seems to be in the spirit of Podani's coinage since he created his term by contrast to "monophyly" *sensu* Hennig, i.e. holophyly.

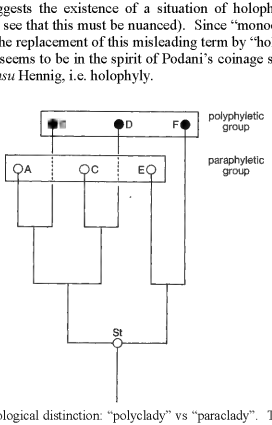

Figure 15. An impossible topological distinction: "polyclady" vs "paraclady". The white circles represent the primitive state of a character while black circles represent the derived state. Figure reproduced with permission from Hennig (1975).

Concerning "paraclady" Podani states himself: "Paraclady means that the group cannot be embedded into a monophyletic taxon [i.e. holophyletic], and it is therefore indication of paraphyly or even polyphyly in the corresponding diachronous classification" (Podani 2009). That is to say, "paraclady" corresponds to both types of heterophyly, and not only paraphyly (see Figure 14B). Symmetrically, the term of heteroclady seems to be more appropriate than the misleading term of

"paraclady". In order to build a complete set of analogous pairs Podani also coined the term "polyclady" (Podani 2010a). Logically, he could not succeed in distinguishing clearly between "paraclady" and "polyclady", and therefore made the later a subcase of the former. Hennig had already faced this problem and had to rely on biological considerations (primitive or derived state of a character) to distinguish these two topologically identical situations (see Figure 15). As noticed by Cavalier-Smith (2010a), the diagram drawn by Hennig do not depicts correctly an opposition between paraphyly and polyphyly since the common ancestor "St" is excluded from both groups. Nelson (1971) proposed to topologically distinguish "paraphyly" and "polyphyly" by defining the first term as a heteroclady with a degree of one and the second term as a heteroclady with a degree strictly superior to one. These definitions were never very successful among taxonomists who have always preferred to refer to the inclusion or exclusion of the common ancestor. It does not seem relevant to me to give different names to different degrees of the same kind of pattern.

Recently some cladists seem to have realized that it was not only necessary to distinguish between the notions of holophyly and holoclady but also to make them coexist by using different terms (Vanderlaan et al. 2013). To refer to them they coined respectively the words "diamonophyly" and "synmonophyly". Two of the coauthors, Williams and Ebach, were however aware of the terms coined by Podani since they blasted this conceptual distinction by commenting his paper (Podani 2009) in their blog[1]. The problem is not, quite the contrary, that they have changed their minds and have finally understood the relevance of this distinction. But beyond the derogatory tone, it is particularly sad that they did not bother to even mention Podani in their own article (Vanderlaan et al. 2013) and did not therefore recognize him the authorship of the idea to distinguish these two concepts by two different words.

The term of "monoclady" was moreover preferable to "synmonophyly" because it deletes the Haeckelian etymon *phylon* which designates the origin of a lineage (Dayrat 2003), yet it is precisely not a matter of origin when talking about holoclady. Furthermore, the use of the prefix "syn-" and "dia-" directly refers to the distinction between synchrony/diachrony, also made by Podani. This distinction is unfortunately very misleading! On the one hand, because some extant species are in fact ancestral to other extant species (see Section 10.2). On the other hand, a diachronic study (i.e. including fossils) can perfectly produce relevant cladograms showing holocladies. The metaphysical distinction between synchrony and diachrony is thus not relevant to taxonomy. One must keep in mind that the set K that is studied is plainly arbitrary and has no relation with the physical notion of time. Even if somehow the orientation of graphs reveals a chronological sequence, it must be understood that the time axis is absent from these representations, which explains that individuals and even taxa are represented by points and not by bars. Finally contrary to Podani, I recommend for the adjectival form to simply use the suffix "-ic" instead of "-istic". It is indeed desirable to distinguish cladic things, i.e. things related to clades or to their properties, from cladistic things, i.e. things related to the treatment of clades in general or to cladistics in particular.

Definition 7.8 *(Crown-Group and Basal Group)* Let there be g a clade defined in K on the network $G = (X, p)$, A the set of all the common ancestors of g, A' the set of all the exclusive common ancestors of g in K and g' a holophyletic group canonically associated to g such that its unique included common ancestor $a \in A'$ is a most recent common ancestor of g. Let us then define the group g'' such that for every $x \in X$, $x \in g''$ if and only if $x \in g'$ and $x \notin K$. The group g'' is called the basal group of the clade g relatively to g'. By opposition g is called the crown-group.

[1] http://urhomology.blogspot.fr/2009/12/paraphyly-watch-4-monoclady-and.html; entitled "Paraphyly Watch 4: Monoclady and Paraclady" ; posted on Monday 7th December 2009 ; accessed on Monday 22th December 2014.

Observation 7.9 Let there be g a clade, g' canonical holophyletic group of g and g'' the basal group of g relatively to g', then it is always true that $g' = g \cup g''$ and $\emptyset = g \cap g''$.

Because the definition of a basal group depends on the canonical holophyletic group on which it is constructed, if this later one is not unique then the basal group is also not unique. In the same way we have expanded the definition of a canonical holophyletic group in the case of heterocladic groups, it is possible to expand to them the definition of basal groups by taking as an intermediary a canonical holocladic group. The crown-group would then be the initial heterocladic group itself (see Figure 17A).

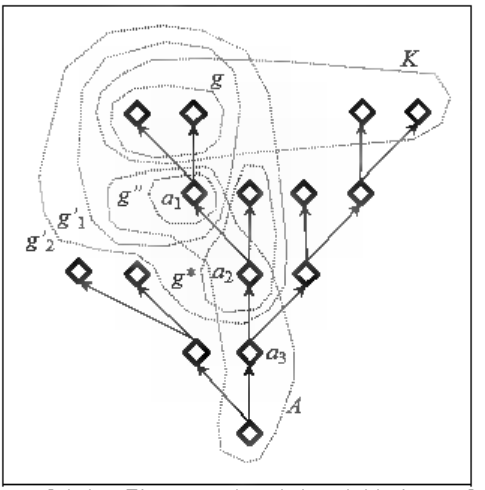

Figure 16. Accessory groups of clades. The group g is a clade and A is the set of all its common ancestors. Among them a_1 and a_2 are exclusive common ancestors in K. The individual a_1 is the most recent common ancestor, so it permits the definition of the smallest holophyletic group canonically associated to g, i.e. g'_1. The basal group g'' is therefore complementary to g in g'_1, here: $g'' = \{a_1\}$. On the contrary, g'_2 is the largest holophyletic group that be canonically associated to g, so it permits the definition of g^* the stem-group of g, the complementary group of g'_1 in g'_2.

Definition 7.10 *(Stem-Group)* Let there be g a clade defined in K on the network $G = (X, p)$, A the set of all the common ancestors of g, A' the set of all the exclusive common ancestors of g in K, A^* the set of all the most recent common ancestors of g, and $H = \{g'_1, g'_2, \ldots, g'_n\}$ the set of all holophyletic groups canonically associated to g. Let us consider one of these groups $g'_k \in H$ with k, $1 \leq k \leq n$, such that its unique included common ancestor $a_k \in A' \cap A^*$. Then we define a stem-group g^* such that for every $x \in X$, $x \in g^*$ if and only if $x \in \bigcup_{1 \leq i \leq k} g'_i$ and $x \notin g'_k$.

Lemma 7.11 *(Anteriority of Stem-Groups)* The unique included common ancestor of a non-empty monophyletic stem-group is never a most recent common ancestor of the clade from which it has been defined.

This lemma shows us that in accordance with intuition, stem-groups are necessarily "older" than basal groups, and *a fortiori* than crown-groups. Basal groups and stem-groups are both called the "accessory groups" of a clade (see Figure 16). The beginnings of these concepts were already present in Haeckel's work (Dayrat 2003).

Like basal groups, delineation of stem-groups depends on the most recent common ancestor that has been selected: if there are more than one, then there are several slightly different stem-groups. These concepts are especially relative since the delimitation of the subset K is itself arbitrary. So in practice, it is always needed to specify in what context a clade is studied before we can talk unambiguously about basal groups and stem-groups. The stem-group witnesses a series of evolutionary innovations that precede the most recent common ancestor of a clade, its study can therefore help to understand how the basal group and the crown-group successively emerged. To take a classical example, it would be very difficult to accurately explain the mechanisms that led to the emergence of the class Aves from the class Reptilia if we were neglecting the study of the stem-group of modern birds, which contains the extinct superorder Dinosauria plus the primitive birds.

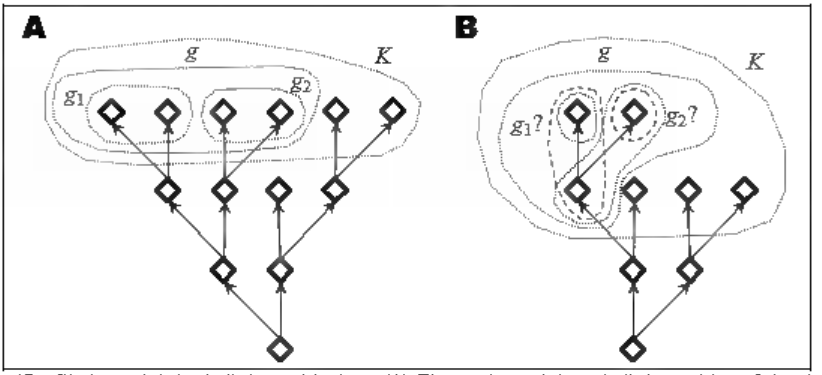

Figure 17. Clades and their cladistic partitioning. (A) The set $\{g_1, g_2\}$ is a cladistic partition of the clade g defined in K. (B) It is not possible to chop up the clade g into two non-overlapping clades, thus this clade have no cladistic partition.

Lemma 7.12 *(Paraphyly of Basal Groups)* Non-empty basal groups are necessarily paraphyletic.

This lemma is however not true concerning stem-groups since they result from the union of potentially several paraphyletic groups whose cenancestors are not necessarily ancestral to each other. A stem-group can thus be polyphyletic.

Lemma 7.13 *(Heterophyly of Stem-Groups)* Stem-groups can never be holophyletic.

The concepts of crown-group and stem-group have developed over the past fifteen years, spreading rapidly in the scientific literature. They do not conform to the current cladist paradigm that regards as useful only clades, as both units of the classification of life and as operational units in the phylogenetic studies. The success of these concepts in this theoretical context that is most unfavorable to them is indicative of the practical need to distinguish the notions of taxon, clade and grade. It is not difficult to assume that without an opportunity to express in a clear language the historical succession of different grades it was tough enough to intelligibly explain the emergence of different taxa through time, i.e. phylogenesis. Similarly, the explosion of the use of quotation marks systematically surrounding the words “reptile” or “fish” rather than the cladists’ desired complete disappearance of these terms says the refinement of a jargon superficially consistent with this paradigm but actually secretly calling for ideas that are contrary to it. In the same way, the spread of

surprising paraphrases such as "non-avian dinosaurs" reflects the unconscious and involuntary hypocrisy into which many colleagues are unfortunately forced.

Moreover, contrary to what one might naively believe the finding of a holoclady is not formally sufficient to conclude immediately that there exists a holophyly: "If a collection of organisms is found to be monocladistic [i.e. holocladic] (in a molecular study, for example), then the taxon which includes this group in a diachronous classification is not necessarily monophyletic [i.e. holophyletic]" (Podani 2009). Indeed, a clade arises from the same stem-group as its sister clade. This implies that stem-groups can either be classified as a taxon in its own right or be united with one of its daughter clades. A wise classification must therefore be based on a rigorous reconstruction of the ancestors in order to classify them.

Cavalier-Smith (2013) wonderfully illustrates how not to fall into such a trap concerning choanoflagellates, a group of paraphyletic protozoans which gave birth to the animal kingdom but whose extant members now form a holocladic crown-group:

"*It is an illusion to claim that choanoflagellates are holophyletic and that one could make a holophyletic phylum restricted to them alone. Prior to the origin of epithelia and mesenchyme the lineage that later led to animals was beyond all reasonable doubt choanoflagellate in morphology and life style; because this lineage did not generate any surviving choanoflagellates, they were stem choanoflagellates not crown choanoflagellates. Crown choanoflagellates (defined as the last common ancestor of all extant choanoflagellates plus all its descendants) are indeed holophyletic. But crown choanoflagellates are a clade and should not constitute a taxon.*"

Let us take this opportunity to point out, as does Cavalier-Smith, how much it is simply impossible to avoid paraphyly in a comprehensive classification based on phylogenetic tree (see Section 5):

"*To create an illusion of 'avoiding' paraphyly, equating Choanoflagellatea with crown choanoflagellates only, would leave stem choanoflagellates unclassified, equivalent to cutting up the phylogenetic tree into pieces, throwing away all the stems, and classifying only the terminal branches – yielding a phylogenetically misleading and fragmented picture of the tree of life. That is not a 'phylogenetic classification' as often claimed, but an incomplete and conceptually defective one.*"

To distinguish cases of obvious paraphyly suggested by heteroclady and cases of paraphyly hidden by holoclady, I suggest using the term "cryptic paraphyly." These cases should be reported in any good classification because they carry important historical information. Thus, a taxon known to be cryptically paraphyletic is also known to be directly ancestral to some other taxa even if its extant members do share an exclusive common ancestor.

8. CLADOGRAMS, CLADIFICATION AND CLADONOMY

Contrary to a Linnaean hierarchy, which uses taxa as classification units, the "classification" promoted by cladists uses clades. This ordering system is called a cladification so as to clearly differentiate it from a classification. Indeed, a classification can be defined as a "hierarchically ordered systems of classes of *similar* objects [my emphasis]" (Mayr & Bock 2002). The composition of clades may instead be very heterogeneous. It is therefore important to distinguish between an "arrangement" and a "classification", as well as between the verbs "to arrange" and "to classify" (see Table 2). This opposition between arrangement of clades and classification of taxa is also made by some cladists, although with different words (Griffiths 1974).

ACTIVITIES

To categorize: To put sets of objects into order. The result is a *categorization*. It is composed of categories, i.e. sets of sets.

To arrange: To put objects into order by assigning ranks to them or by distributing them into sets according to certain criteria. The result is an *arrangement*.

To classify: To distribute objects into distinct *classes*, i.e. sets whose members share a greater *affinity* with each other than with members of the other such sets. The result is a *classification*, a particular type of arrangement.

To group: To join distinct individuals together into larger and larger sets (upward strategy). The result is a *grouping*, a particular mode of arrangement or categorization.

To hierarchize: To assign ranks to sets of objects. The result is a *hierarchy*, a particular type of categorization analogous to rankings regarding arrangements.

To rank: To assign ranks to objects so as to order them into a certain sequence (alphabetical, chronological, etc.). The result is a *ranking*, a particular type of arrangement.

To sort: To successively divide a set of distinct individuals into smaller and smaller sets (downward strategy). The result is a *sorting*, a particular mode of arrangement or categorization.

DISCIPLINES

Cladonomy: Side activity of systematics which consists in allocating scientific names to clades. Cladists recognize these clades as natural groups and arrange them into a cladification, which is truly an arrangement but not a classification.

Phylogenetics: Discipline that aims at reconstructing the evolutionary history of the living world so as to explain its progression (i.e. phylogenesis) by making a synthetic structured representation of it (i.e. phylogeny). In practice, phylogenetics handles groups that have been identified by taxonomy and cladonomy.

Systematics: Scientific study of living organisms in their diversity and their evolutionary relationships. Systematics comprises two complementary facets: phylogenetics and taxonomy.

Taxonomy: Discipline whose field of research includes identification, description, recognition and classification of the organisms of the living world into groups called taxa. One of the main goal of taxonomy is thus to establish a natural classification based on phylogeny *and* phylogenesis.

DOCTRINES

Dialectics: Epistemological doctrine according to which reality is a continuum whose elements are intimately linked to each other. Dialectics is consequently characterized by a systemic approach, considering that a whole can be greater than the sum of its parts (holism, emergentism). Everything that exists would therefore be composed of a single substance (monism) that constantly changes (thus according to Heraclitus "all entities move and nothing remains still"). In its idealistic version reality is therefore a spiritual flow (e.g. Leibniz, Hegel, existentialism), while

in its materialistic version reality is nothing else than the history of the matter, whether this later is considered fully knowable (e.g. Marx, Darwin, Einstein) or not (e.g. Nietzsche, poststructuralism).

Idealism: Ontological doctrine according to which reality is fundamentally mental or of spiritual nature. In its realist version general ideas are accorded a proper existence outside of the thinking subject (e.g. Plato, vitalism), whereas nominalists see in them only abstract constructions, thus recognizing only particular perceptions as the sole realities (e.g. Berkeley).

Materialism: Ontological doctrine according to which the ultimate nature of any being is material (e.g. Democritus, mechanism). There are therefore neither spirits nor ideas outside the body, and mental phenomena are explained by a particular organization of matter (physicalism). In its nominalist metaphysical form, experimental refutation is often regarded as the only source of a generally temporary truth (e.g. Popper). Inductive reasoning and use of statistics are instead approved by realists (e.g. Comte, Poincaré) and dialecticians (e.g. Kuhn).

Metaphysics: Epistemological doctrine according to which knowledge is obtained through analysis of reason (rationalism) and/or of sensory experience (empiricism). Metaphysics thus has a strong trend to consider that everything can be reduced to its parts (e.g. Spencer, Wilson, scientism). This way of thinking also involves regarding movements or changes as disturbances masking the universal and eternal truth (e.g. Cuvier, fixism; according to Parmenides "being is, but nothing is not"). Metaphysicians therefore generally believe that the world is divided into several unassimilable entities (e.g. mind/matter dualism of Plato or Descartes, pluralism of Aristotle's categories).

Nominalism: Gnoseological doctrine according to which knowledge of reality is partly or totally necessarily inaccessible for experience and our understanding. In its materialist version, science consists therefore only in the study of relationships between the manifestations of reality (phenomena) but must refrains from speculating about the underlying causes (e.g. Locke, Hume, neopositivism, structuralism). In its idealist version, the whole of reality is seen as a pure mental representation, which has the effect of denying the existence of any objective reality outside the subject (e.g. Schopenhauer, Bohr, instrumentalism, constructivism).

Realism: Gnoseological doctrine according to which reality is plainly accessible to our knowledge. As a consequence, in its dialectical version it rejects the dichotomy phenomenon/thing-in-itself (e.g. Spinoza, Haeckel, Bell, Bohm, naturalism). In the same way, subjects and objects are considered as relative concepts, thus allowing the study of the production of knowledge by scholars as if it were a natural phenomenon.

Table 2. Glossary. I retained a few basic definitions of disciplines and activities discussed in this paper that are not the subject of a formal mathematical definition. The definitions of the philosophical doctrines are exemplified by a few authors (philosophers and/or scientists) and also by some distinctive movements.

Definition 8.1 *(Cladistic Partition)* Let there be g a clade defined in K on the network $G = (X, p)$. The set $\{g_1, g_2\}$ is a cladistic partition of g if and only if g_1 and g_2 are clades such that $g_1 \cap g_2 = \emptyset$ and $g_1 \cup g_2 = g$. Then, both groups are called sister clades.

Observation 8.2 *(Existence)* There does not always exist a cladistic partition of a clade, even if it is composed of several elements.

The problem revealed by this observation is depicted in Figure 17B. It comes directly from Theorem 5.4 according to which a continuous partition of a continuous group (which can be the case

of a clade) necessarily contains at least one paraphyletic group (which can*not* be the case of a clade) if it comprises at least two elements. As it has previously been said, it is impossible to remove *a priori* an ancestor in a cladistic study (whether it is synchronic or not). The ancestral status of a taxon can only be determined *a posteriori* after the examination of all available data (cladistic, palaeontological, ecological, etc.).

Theorem 8.3 *(Uniqueness)* In a network without mergings a cladistic partition of a clade, if it exists, is always unique.

Since mergings are rather rare in evolution of higher taxa then this theorem globally validates the cladistic method for phylogenetic reconstruction. This result should not be nuanced by the existence of horizontal gene transfers (HGT) between branches, particularly among bacteria. Genes and organisms bearing them should indeed not be confused. The goal of phylogenetics is to reconstruct a genealogy of organisms, not of genes (Valas & Bourne 2010). Although these HGT can interfere with evidences of heredity, one must keep in mind that a gene must be copied: it does not grow and does not divide, contrarily to a cell. It is astonishing to have to remind this, but the unit of life is cell, not gene. Confusion may come from the unfortunate term "molecular phylogeny" and some bad popular science papers talking about DNA as a magic molecule containing all the answers to the mysteries of life. By the way, DNA is not alive. Thus, confusing the tree of life with a tree of genes is a kind of vitalism. Then, the relation p should never be read as "x_1 donates genetic material to x_2", as Kwok (2011) misleadingly suggested.

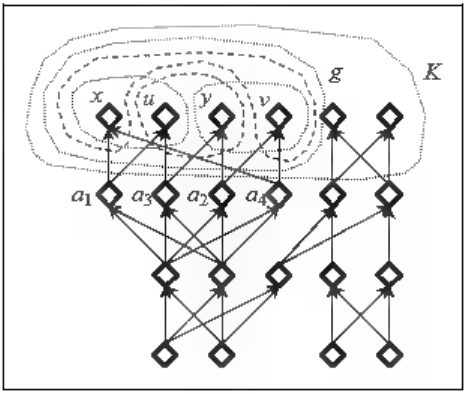

Figure 18. Alternative cladistic partitions in a network with mergings. The clade g defined in K has two different cladistic partitions: $\{\{x, u\}, \{y, v\}\}$ or else $\{\{x, v\}, \{u, y\}\}$.

By opposition, in a network with mergings it is sometimes possible to split a clade into several different cladistic partitions (see Figure 18). This is not a particularly surprising result; it actually corresponds to haplogroups in population genetics. The dividing of humanity into distinct haplogroups is known to have been especially helpful in the reconstruction of its oldest migrations through continents. Globally, networks without mergings can be used as a model for phylogenies in supraspecific levels, whereas networks with mergings are more appropriate as a model for genealogies in infraspecific levels. But it is clear that in reality there exists a continuum between these two situations, there are not of different nature.

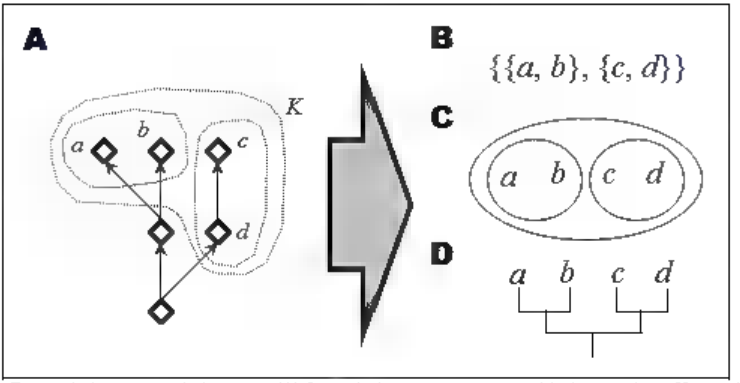

Figure 19. From phylogeny to cladogram. (A) In a phylogeny, we are considering a subset K containing four species a, b, c and d. (B) Clades are embedded according to the formalism of set theory. (C) Venn diagrams are an intuitive form of graphical representation. (D) Cladograms are easier to read, but they have the disadvantage of making one to believe that branches and nodes represent something: they are not genealogical trees.

Definition 8.4 *(Cladogram)* Let there be g a clade in K on network $G = (X, p)$, and $\{g_1, g_2\}$ a cladistic partition of g. A cladogram of g is a set $\{c_1, c_2\}$ such that $c_1 = g_1$ or else c_1 is a cladogram of g_1, and likewise $c_2 = g_2$ or else c_2 is a cladogram of g_2.

A cladistic partition is thus a very simple cladogram. This iterative definition allows representing cladograms as Venn diagrams, thus emphasizing that the branches of cladograms are nothing else but an alternative representation of embedded sets (see Figure 19). These branches does not represent lineages, cladograms are therefore neither genealogies nor phylogenies! Thus, the nodes do not represent ancestors but only higher clades. Finally, clades in themselves do not represent phylogenetic relationships since different processes as the splitting of a mother species into two daughter species or else a daughter species arising from a surviving mother species, lead to identical cladistic representations (see Figure 19). Contrarily to what is sometimes claimed (Martin & Wiley 2010), and although cladograms do have the form of a tree, they are not based on graph theory but only on set theory. The construction of cladograms is the goal of cladistics. We can call cladonomy the naming of the different clades embedded within each other (Brummitt 1997). The result of cladonomy is a cladification, i.e. a cladogram whose nodes are named. But a cladogram is only a preliminary arrangement which must be rigorously interpreted with regard to *all* available data in order to reconstruct the true phylogeny. A simple clade $\{a, b\}$ can be interpreted in five ways (see Figure 20)! Consequently, by Theorem 5.4 and by Observation 8.2, it is clear that a classification of species can be based neither on strict holophyly nor on strict holoclady. Let us recall that another mathematical analysis of these concepts, although based on cladist assumptions, came to a similar conclusion (Kwok 2011).

9. ESTABLISHMENT OF THE CURRENT PARADIGM

The theoretical weaknesses of cladism we have highlighted in previous sections naturally lead us to examine the reasons for its success. Firstly, cladism proposes to directly convert cladograms into ersatz hierarchical classifications by removing a laborious step of expertise to delineate the different potential groupings (Hennig 1966). Secondly this doctrine was shipped with a rigorous and relatively simple method for constructing these very cladograms. And thirdly, ancestors, whose classification was particularly complex, were axiomatically eliminated. This therefore simplified

both phylogenetic and taxonomic work. The quick acquisition of precise and reproducible results, so apparently objective (Hennig 1975), promptly defeated the counter-arguments of traditional taxonomists who insisted on the lack of relevance and realism of these results (Mayr 1974).

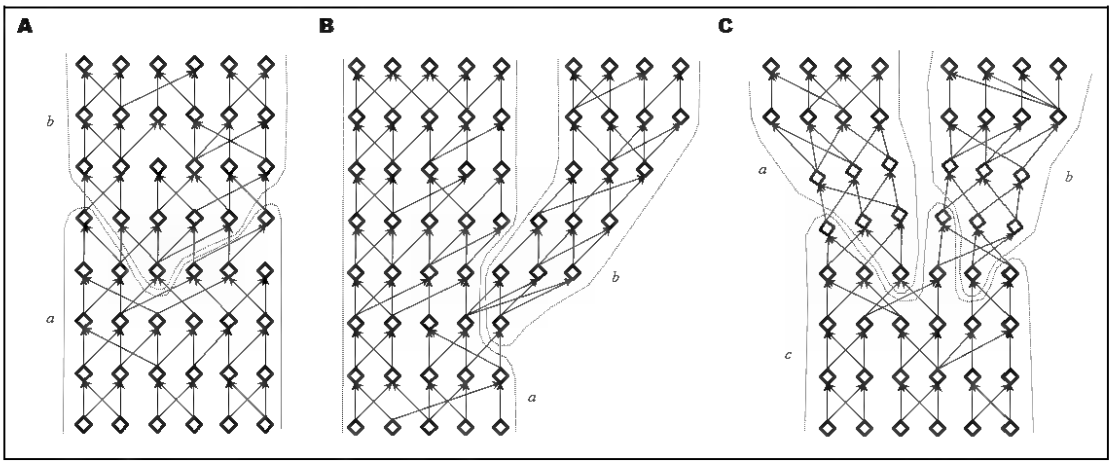

Figure 20. Relationships between clades and phylogenetic reality. A cladistic partition {*a*, *b*} can be interpreted in five different ways. (A) One anagenesis: a mother species *a* turns into a daughter species *b* (or the reverse); this type of speciation is generally sympatric. (B) One cladogenesis and one anagenesis: a daughter species *b* buds from a persisting mother species *a* (or the reverse); this speciation is usually peripatric. (C) One cladogenesis and two anageneses: a mother species *c* disappears by giving birth to two daughter species *a* and *b*; this type of speciation may appear in allopatric contexts.

In a Kuhnian perspective, the period of the years 1960-1970, which saw the rise of cladism, can be called a scientific revolution. The intuition and expertise of a few taxonomists were indeed at the heart of this discipline in the early twentieth century, methods of phylogeny reconstruction were so poorly formalized and principles for deciding between alternative classifications were even vaguer. Systematics was suffering from a poor image and was desperately looking for "scientific respectability" (Dumoulin & Ollivier 2013). This practice through trial and error in restricted circles can be called a pre-paradigmatic situation. The arrival of a rigorous approach with clearly defined aims put an end to it, and brought systematics into a new paradigm, that of cladism. We call "paradigm" a set of opinions shared by practitioners of a discipline that guides researches, permits identification of the problems to be solved, determination of acceptable methods, and judgement about the plausibility of the findings (Kuhn 1962).

A paradigm is a constraining framework of thought, it mainly acts unconsciously and it greatly influences how we interpret experimental data and discourses from our peers. This last point may seriously affect scientific communication when researchers working within different paradigms (often incompatible) try to share their results or theories. Thus, we can read for example in a review of a book of Zander (2013): " 'this book rejects the idea that [...] a clade is necessarily monophyletic' (p. 5). This position is so different from the familiar cladistic perspective that at times I found it difficult to comprehend" (Brower 2014). The problem does not come from the obscurity or the complexity of the topic, but from a real subjective difficulty in understanding concepts that do not belong to the paradigm we are used to (here Zander is only drawing attention, through his own vocabulary, to the existence of cryptic paraphyly in a context of holoclady, see Section 7). I will develop this aspect through two historical disputes.

ONTOLOGY	GNOSEOLOGY	EPISTEMOLOGY	SCHOOL	REPRESENTATIVES
Idealist	Nominalist	Metaphysical	Cladist (pattern)	Ebach MC, Nelson GJ, Patterson C, Platnick NI, Williams DM
		Dialectical	Pheneticist (or numerical)	Sneath PHA, Sokal RR
	Realist	Metaphysical	Essentialist (or typological)	von Linné C, Cuvier G
		Dialectical	Gradist	Haeckel EH, Lamarck JB
Materialist	Nominalist	Metaphysical	Cladist (process)	de Queiroz K, Farris JS, Hennig W, Woese CR
		Dialectical	-	Darwin CR
	Realist	Metaphysical	Evolutionist (classical)	Ashlock PD, Cronquist AJ, Mayr EW, Simpson GG
		Dialectical	Evolutionist (modern)	Cavalier-Smith T, Hörandl E, Stuessy TF, Zander RH

Table 3. Philosophical classification of the main schools of systematics. Philosophy of knowledge can be divided into three fields of study that are about three great fundamental and interrelated questions. Ontology: What is reality? Gnoseology: What can we know? Epistemology: How can we know? (see Table 2) This categorization, which is for educational purposes, is obviously very schematic and do not report the subtleties and inhomogeneities in each school of thought. The few authors presented for information purposes in the last column have been classified only with regard to their *actual* practice of taxonomy, and not with regard to their theoretical statements or practice in other areas of biology. The quality of their scientific work cannot be appreciated at its true value only by their positions (which are approximate) in this table.

As we have previously explained, Ashlock (1971) coined the term "holophyly" to reflect the concept used by cladists under the misleading name of "monophyly". Despite several exchanges around the problem raised by the original article (Nelson 1971; Ashlock 1972; Nelson 1973), it seems that cladists involved in this dispute never understood that Ashlock's remarks were purely nomenclatural, his aim was that supporters of both schools could argue their views without being confused by unnecessary terminological quarrels (Vanderlaan et al. 2013). While one might naively interpret the attitude of Nelson as ill will, the analysis of his words allows us to understand that what he meant by "monophyly" is actually the concept of holoclady. Similarly the distinction between what he calls "paraphyly" and "polyphyly" corresponds in fact to different degrees of heteroclady. Since the concept of monophyly *sensu* Ashlock encompasses both the holophyly and paraphyly, Nelson could only have imagined that Ashlock aspired to a word encompassing both concepts of holoclady and heteroclady, which is clearly useless… Hence the misunderstanding and the extension of this terminological controversy.

One of the characteristics of a paradigm striving to impose itself is looking for support from major scientific figures. This often takes the form of a re-interpretation of texts written by famous and established authors. They are then considered as precursors of the new paradigm, thus allowing their authority to redound to it. Thus, it is common to find in the cladist literature statements such as

"Darwin was very clear that genealogy should be the only criterion of classification" (Padian 2004). Although it is anachronistic to make Darwin an adherent of one of the two schools of classification born in the mid twentieth century (Padian 1999), such a conclusion still seems to favour Darwin's interpretation as a precursor of Hennig and cladism. The problem stems from the cladist view that today's scientists take on the meaning of the vocabulary used by Darwin. It is clear in particular that the word genealogy has radically changed its meaning in the meantime: firstly Darwin did not have at his disposal the term "phylogeny" coined later by Haeckel, and secondly cladists now tend to use this very word to refer to the sequence of dichotomies in a cladogram. Thus, it can be read:

"*I believe that the ARRANGEMENT of the groups within each class, in due subordination and relation to the other groups, must be strictly genealogical in order to be natural; but that the AMOUNT of difference in the several branches or groups, though allied in the same degree in blood to their common progenitor, may differ greatly, being due to the different degrees of modification which they have undergone; and this is expressed by the forms being ranked under different genera, families, sections, or orders.*" (Darwin 1859)

Although the first part of the sentence seems to go in the direction of a "pre-cladist" interpretation, the second part leaves very little doubt as to Darwin's view about importance of the degree of similarity in the making of a classification as natural as possible (Mayr & Bock 2002). Statements like "Darwin never endorsed similarity as the other half of a 'dual criterion,' " (Padian 2004) are therefore at best highly dubious. When cladists read that a classification "must be strictly genealogical" they understand most of the time "holophyletic". When Darwin wrote that a classification "[should] be strictly genealogical" he probably only meant "monophyletic" and was certainly not much concerned about paraphyly. Our Theorem 6.2 states by the way that phylogenies are genealogies. From this point of view, it is quite possible for an evolutionary taxonomist to say that genealogy alone does give a classification! Anyway, it is once again important to note that in Victorian era the problem of phylogenetic reconstruction was in its infancy, which explains that in practice the classifications established by Darwin were only based on phenetic criteria (see Table 3). We may eventually regret a too metaphysical reading of this issue by some evolutionists (Mayr 1974; Mayr & Bock 2002) who see in it the use of a "dual criterion," genealogy and similarity, whereas in Darwin's mind, similarity (or "affinity") was actually a reflection of genealogy.

10. ANALYSIS OF THE CLADIST DOCTRINE

Cladism as it was founded by Hennig is based on three key assumptions. The first is that cladograms' nodes do represent real speciation events through splitting (Hennig 1966; see Figure 20C). The second is that it is extremely unlikely, given the continual transformation of the living world and the vagaries of fossilization, that a species we know is the ancestor of another one. Even if by chance this ever happens, it would be anyway impossible to prove this parental link. The third, more implicit, is that the evolution of species is occurring at a more or less constant rate (uniformitarianism, not to be confused with actualism). This would imply that the more recent is the divergence between two species, the more similar these two species are. Clades would therefore be the kind of groups with the maximum content in phenetic informations.

10.1. Structuralist Influence

The presumed speciation mechanism requires taxonomists not to consider any species as ancestral to another one, and thus to classify them only as sister groups. This dogma according to which reality is not accessible to us is characteristic of a *nominalist* philosophy of knowledge: science aims to model and predict manifestations of reality but not to understand reality itself. The ordering system advocated by Hennig (his "phylogenetic classification") is thus more a reflection of our knowledge of manifestations of reality (distribution of characters, fossils, etc.) than a theory *of* reality. However, this is not a radical kind of nominalism which would imply that reality is entirely

unknowable, or even that it does not exist. Hennig did recognize the material nature of reality and its independence of the subject. This can be seen through his attachment to the fact that successive branchings of cladograms do represent an evolutionary process. This is clearly a *materialist* position.

Finally, the Hennigian conceptual framework can be described as *metaphysical* since it is both rigidly static and reductionist. Indeed, its phyletic arrangement does not reflect any transformation (no species becomes another, no group emerges from another group, etc.) and is reduced to represent only the structure of the process supposed to be at work (the splitting of a mother species into two daughter species). In this regard, it is significant to note the almost complete disappearance of the concept of phylogenesis in our current practice of systematics. Coined by Haeckel (1866), the term "phylogenesis" refers to a real *developmental process* ("Entwickelungs-Vorgang" in the original) that must be contrasted with the term "phylogeny" coined later (Haeckel 1868) which refers to a reconstructed *history of the development* ("Entwickelungsgeschichte" in the original). This opposition is more or less of the same kind as our modern *process*/*pattern* opposition, even if this vocabulary was coined later (Dayrat 2003).

To understand the history of science it is essential not to naively conceive it as a fully autonomous entity developing only through gradual accumulation of observations and refutation of increasingly efficient theories. Science is not independent of the society in which it operates; it is a byproduct of it. As such, its practice is subject to the various ideologies that have impregnated society. Systematics is no exception to this trend, which enables us to examine the cladist dogma in the context of its time. Yet, among the modern philosophies of knowledge, both materialist and nominalist, and having a metaphysical method (see Table 2), the main general school is *structuralism*: science then aims to discover the intrinsic structures of the manifestations of reality while refraining from speculating about its nature or the underlying mechanisms. The structuralist movement (emphasizing synchronic structures rather than diachronic causes) emerged in the early twentieth century in the field of linguistics and has then greatly influenced many other scientific disciplines. In physics for example it gave birth to the *instrumentalist* school, which culminated with the so-called Copenhagen interpretation of quantum mechanics (Nikolic 2007). This relationship between structuralism and cladism has already been raised by other authors (Grande & Rieppel 1994; Zander 2011).

10.2. Paraphyletic Species

If the speciation mechanism envisaged by Hennig were correct, it would imply that absolutely all extant species should be holophyletic. However, speciation by splitting is a complex mechanism that requires the occurrence of two divergent anageneses immediately after an event of cladogenesis (see Figure 20C). It is much more likely that species originate mostly by simpler mechanisms (Mayr 1974) such as direct transformation of one species into another (see Figure 20A) or by budding of a single daughter species from a mother species (see Figure 20B). It is ironic that cladistic analysis (and cladism in general) is largely based on the principle of parsimony, while the axiomatic existence of an unobserved mother species giving birth to the two observed species appears as a superfluous hypothesis! A hypothesis even more flawed since the mother species is not only unobserved, but by definition *unobservable*, which logically makes it both unverifiable and irrefutable. In fact, it is estimated that about 20% of extant species of plants and animals are paraphyletic (Rieseberg & Brouillet 1994; Crisp & Chandler 1996; Funk & Omland 2003; Crawford 2010; Schmidt-Lebuhn et al. 2012; Ross 2014).

It is hardly surprising that cladists have adopted a very formal concept of species, but also a very fanciful one, allowing among other things getting around this problem. This so-called "phylogenetic" concept of a species conceives it as a lineage between two events of cladogenesis (or extinction). The problem is that it is an artificial criterion that completely ignores the possibility of

anagenesis within the same lineage, and also paradoxically ignores the possibility of an absence of anagenesis in one of the two daughter lineages (budding mechanism). This purely conventional definition does not correspond to biological reality (while the goal of biology is precisely to describe and explain this reality), and is much less relevant than alternatives based on empirical properties of species: reproductive isolation (for eukaryotes only), ecological cohesiveness (within a restricted adaptive zone), morphological similarity, etc.

But we should not see them as competing definitions; all these properties are actually dialectically related to each other. For example, morphological similarity results from both stabilizing selection in a certain ecological niche, but also from genetic recombination through sexual reproduction. But the fatal flaw of the phylogenetic species concept is that it is not even logically consistent, which is revealed with force if one tries to rigorously model it using mathematics(Velasco 2008). One could be tempted to see in this matter an idealist drift of Hennigian nominalism, since instead of trying to organize empirically observed phenomena it attempts to integrate them into some aprioristic categories, non-amendable through experience (like the concept of "phylogenetic" species). This does have the advantage of allowing researchers to work with very precise concepts, because aprioristically devised, but they are too often simplistic, or even frankly irrelevant. It is profoundly unreasonable to replace imprecise but relevant concepts by precise but irrelevant ones.

10.3. Virtual Ancestors

The second postulate of cladism concerns the non-fossilization of ancestors, or the impossibility to formally recognize them as ancestors, is empirically false (Prothero & Lazarus 1980; Paul 1992; Benton & Pearson 2001; Prothero 2009). In simple terms, if two morphologically slightly different fossil species succeed each other in two adjacent geological layers, the simplest and least costly hypothesis is that one is descended from the other (parsimony). In absence of evidence suggesting an alternative scenario, it is unnecessary to systematically admit the existence of a third species, of which we have no vestige, and which would be the mother of the two observed fossil species. The first assumption is verifiable or refutable depending on whether subsequently discovered evidences are consistent with it or not, while the second hypothesis is neither verifiable (since the discovery of a third fossil ancestral to the first two would automatically be interpreted, in a cladist framework, as a sister species of the other two) nor refutable (since the hypothetical ancestor is unobservable). It is quite surprising in this regard that in its efforts to establish itself as a new paradigm, cladism heavily relied on the philosophy of Popper (Rieppel 2008; Vogt 2014), and in particular on its highly prescriptive falsificationism which specifically prohibits the consideration of such irrefutable assumptions.

In addition, if a fossil or living species may be paraphyletic, why not a genus, or a family, or an order, etc.? Two options are open to cladists. The first is to abandon species as the base unit for their phyletic arrangement to finally class only individual organisms into clades without ranks. It is therefore rather difficult to talk about a "natural" arrangement. The second option is to take into account the biological reality of species by restricting their fight against paraphyly only to higher levels of the classification. The first solution is clearly a radicalization of nominalism (thus tending towards an idealist nominalism), while the second one is just an adjustment preserving materialism. But, is holophyly sufficient for guaranteeing the naturalness of taxa higher than species (genera, families, orders, etc.)?

10.4. Uniformitarianism and Punctualism

It is rather clear that cladists see paraphyly as an artificial cut making clades incomplete and therefore unnatural. But what is truly meant by "natural"? Even before the publication of the *Origin of Species* (Darwin 1859), naturalists of the Victorian era shared the view that the Linnaean classification reflected real relationships of "affinity" between organisms. The origin of this affinity,

which allowed the constitution of nested groups, was then unknown (Winsor 2009). As we know, Darwin proposed that this mysterious affinity was in fact the expression of common ancestry, and then that a natural classification had to be genealogical. Does our classification still reflect such an affinity today? Trying to answer this very question involves defining the concept of affinity without referring to either genealogy or evolution; we might otherwise produce a circular reasoning. Thus, according to Gilmour (1937), a natural classification is an "arrangement of living things which enables the greatest number of inductive statements to be made regarding its constituent groups, and which is therefore the most generally useful for the investigation of living things". That is to say, naturalness means maximizing the *overall similarity* of organisms within groups thus formed, while minimizing it between these very groups. It is indeed such a principle that taxonomists used to follow before the introduction of cladism.

The problem that arises here is the apparent discrepancy that often exists between the degree of kinship and the overall similarity (Mayr 1974; Ashlock 1979). Thus, although crocodiles are phyletically closer to birds than to lizards, it is indisputable that the predecessors and contemporaries of Darwin did wonder about the affinity they noticed between crocodiles and lizards, not between crocodiles and birds. Contrary to what states the third postulate of cladism cited above, the pace of evolution can greatly vary (Eldredge & Gould 1972; Gould & Eldredge 1977; Cavalier-Smith 2006; Cavalier-Smith 2010a; Zander 2010). It may be argued that the morphological differences that we perceive are in fact very superficial; organisms that look alike might actually be quite different from a molecular point of view, and *vice versa* (Schmidt-Lebuhn 2014). Indeed, only a small part of a genome is actually involved in coding the macroscopic phenotype. The goal of taxonomy remains however to classify organisms and not just their genomes. Otherwise we would believe that organisms can be reduced to their genomes, which is a mark of a flagrant reductionist reasoning, as if phenotype were only the rough expression of genotype that would then be the true essence of the organisms we wish to classify. This is not very far from a kind of *essentialism*, a notoriously outdated philosophy.

Moreover, it is now established that molecular characters can also undergo some very abrupt evolutionary accelerations (Shavit et al. 2007). In practice, molecular phylogeneticists are well aware that in order to reliably resolve phyletic relationships between distant organisms one must try to eliminate the parts of the genome that have irregularly or quickly evolved for statistical reasons. What interest would it have to classify organisms solely on the basis of molecular variations that have no functional impact and therefore no adaptive value? If these characters are actually valuable to reveal phyletic relationships, they are however of no value for us to make predictions about the body plan, the physiology and the ecology of an organism; see for example George (2014) for a concrete case. Consequently we can now read all over, in scientific literature and its popularization, some absurdities such as man *is* a bony fish (Brummitt 2006). Following the same reasoning (Aubert 2013) we will soon have to say that man *is* a bacterium, the latter being paraphyletic even if one excludes archaebacteria: "Most papers […] make this very mistake by treating eubacteria as holophyletic, whereas they are almost certainly paraphyletic" (Cavalier-Smith 2010a); see also Jékely (2007) and Cavalier-Smith (2014).

Darwin's *descent with modification*, which is the heart of the genealogical explanation of affinity, actually covers two contradictory principles: heredity and variation. The first explains why two organisms with a common ancestry may (not "must") exhibit a certain affinity while the second explains why they may not (not "must not"). It is *natural selection* (stabilizing or directional selection, or genetic drift) that realizes these potentialities. Affinity reflects therefore the whole Darwinian evolutionary mechanism (not just the topological aspect of genealogy). Instead, cladism tacitly relies on an *uniformitarian* (metaphysical) reading of Darwinian gradualism, while the latter was rather a precursor of modern *punctualist* gradualism (which is dialectical, not to be confused with

saltationism which is also metaphysical). Thus, everything leads us to believe that there is a strong conceptual relationship between the principle of parsimony used in the original cladistic analysis and the rejection of paraphyly. However, as an evolutionary model, the principle of parsimony is empirically false; it notoriously leads to an artefact called long-branch attraction (LBA), thus forcing systematists to develop methods of phylogenetic reconstruction based on more complex evolutionary models and superior statistical analyses (e.g. Bayesian inference).

10.5. Idealist Drift

Empirical objections we can oppose to cladism are likely anomalies within this paradigm. However, a paradigm would not be a paradigm if it were wobbling when facing any difficulty. Besides sociological reasons I will not detail (authority of old scientists, marginalization of non-conformist scientists, psychological and political tensions, etc.), there are also objective reasons that explain the resistance of a paradigm to change. Thus, the deep philosophical and taxonomic decline caused by the advent of cladism was accompanied by a revolutionary progress, through the mathematization it made possible, in phylogenetic techniques. The efficiency of this system thus makes the possibility of its refutation somewhat extraordinary, which then requires a stack of extraordinary evidences. It is actually less costly to simply ignore the anomalies or to adapt to it by amending the paradigm with *ad hoc* hypotheses (at least to some extent).

In the first case we deal with traditional cladism (called process cladism), now mainly represented by numerous molecular phylogeny papers that simply (in a reductionist framework) classify genomes instead of classifying organisms. In the second case we have a minor kind of neocladism (called pattern cladism) that radically rejects any kind of realism and defends the idea that cladistic analysis and cladist arrangement that follows can be aprioristically justified without referring to any theory of evolution or any evolutionary model. Since characters are not weighted, then some of the early cladists, but not Hennig (1966), denied that the cladistic analysis was based on an evolutionary model (Farris 1983). This way of introducing impervious and fundamentally opposing categories (i.e. with or without weighting) is a typical metaphysical thinking. Yet, as rest is not the opposite of movement, the so-called "absence" of weighting is actually an equal weighting, thus undeniably making it an evolutionary model (unfortunately empirically false).

While conventional cladists have long acknowledged this fact by developing more complex evolutionary models, neocladists still try to deny it by rejecting theory of evolution as foundation of cladistic methods. The main line of defence of this position is simply that the principle of parsimony allows an optimal "classification" in terms of information content from a matrix of character states (Brower 2000). That the arrangement is optimal is one thing, but that history matches this very arrangement is another (Felsenstein 1978). Thus, the application of the principle of parsimony (in phylogenetics) to reconstruct the actual evolutionary history is rationalized only through its classificatory properties (in taxonomy). This serious confusion between taxonomy and phylogenetics (see Table 2) leads *de facto* to a purely descriptive arrangement without any historical relevance. It is then not surprising that some systematists did not hesitate to connect pattern cladism with pheneticism (Halstead 1980; Ridley 1983).

This singular philosophy inevitably gave birth to new cladistic methods such as the famous three-taxon analysis (Nelson & Platnick 1991). This strategy of "phylogenetic reconstruction," which treats individually each character for each possible group of three species, results in minimizing the number of homoplasies while traditional cladistic analysis results in minimizing the number of necessary transformations on an optimal tree (Marques 2005). This does well maximize the information content of the groups thus reconstructed, but fails to distinguish synapomorphies (shared derived characters) and symplesiomorphies (shared ancestral characters). The obtained groups are therefore not clades! It is hardly surprising that a method so remote from biological transformism has

been strongly criticized by conventional cladists (Farris & Kluge 1998) and even considered an idealist abuse of the principle of parsimony (Harvey 1992). Philosophy of pattern cladism originally aimed at justifying traditional cladistic analysis independently of any evolutionary model, but since existence of evolution is not recognized then it fails to group species according to their synapomorphies (Farris 2012). This leads to a most ironic situation: some pattern cladists go up to confuse homology and synapomorphy ("symplesiomorphy and synapomorphy are no longer necessary terms: only homology has any evidential value"; Ebach et al 2013), which did not fail to be immediately regarded as a disguised reintroduction of paraphyly in taxonomy (Farris 2014).

As admitted by its own supporters, neocladism is a kind of renunciation of phylogenetic reconstruction: "relative relationships, in the sense of sameness or homology, are better ways to classify and summarize overall taxic relationships than inferring genealogies or phylogenies" (Williams et al. 2010). Such a divorce between taxonomy and phylogeny may seem surprising from biologists yet recognizing transmutation of species (transformism). But this recognition is actually purely formal: "Pattern cladistics was — and still is — a reaction against transformational 'phylogenetics', be that of taxa (Ernst Haeckel) or characters (Willi Hennig, numerical cladists, etc.)." (Williams and Ebach 2008). This neocladism, ostensibly anti-transformational, is therefore an heir of ancient Eleaticism and logically reached the same fixist paradoxes, such as the famous stationary flying arrow (at any instant a flying arrow occupies a space equal to its volume, yet since movement is a change of position then the arrow is always at rest…). Prophetically, pattern cladism was rightly connected to the fixist metaphysical idealism of Agassiz (Rieppel 1988) even before the controversy about three-taxon analysis.

10.6. Pitfall of Nominalism

Cladism, as a kind of nominalism, categorically forbids speculation about entities considered as unobservable. Hypothetical common ancestors located at cladograms' nodes are such entities (since cladograms are not genealogies). Therefore, they do not correspond to any diagnosable species. Thus, if an ancestor species of a taxon were revealed to us, we would have to represent it as a sister clade and not as a node (Nelson 1973). So we can consider that kinship relations depicted by cladograms are either ambiguous (see Figure 19) or purely fictional (see Figure 20). As in a family, there is the same degree of kinship between a mother and her daughter as between two sisters. Yet the relationships between a mother and her daughter or between two sisters are fundamentally different from a historical perspective. It is often argued that cladograms depict sisterhood relationships rather than ancestor-descendant relationships (Lecointre et al. 2008), but it's wrong! As we have shown, cladograms are simply unable to distinguish a relationship between sister groups from a relationship between ancestor and descendant. From this point of view it seems extremely difficult not to find contradictory that a "classification" that so poorly reflects evolutionary history really at work considers itself an heir of Darwin's genealogy and even describes itself as "phylogenetic".

But perhaps we could better understand this matter by briefly examining entities that cladists believe they class. Hennig indeed reduced organisms to "semaphoronts," that is to say bearers of characters. As such, cladists do not class real organisms, but only abstract matrices of characters. The problem is not the manipulation itself of simplified representations of organisms, but the lack of return to reality (which would be "speculative" for anti-realists). So we end up with purely descriptive results, devoid of any explanatory power. The refusal of seeking to infer a real relationship (history) between real entities from abstract links between ideas is a classical pitfall of nominalism: it radically fails to formulate theories because a theory is an explanation of reality. A cladogram is therefore not a theory, but a simple descriptive model (this type of model is generally a preliminary step before the formulation of a theory, while a predictive model is a simplification of a pre-existing theory in order to obtain exploitable predictions). It is particularly important in science

not to confuse a map and the territory it represents; cladist nominalism yet fall into this trap paradoxically because of its negation of the territory. It is rather difficult to reason correctly about a map that does not represent anything real, which effectively leads to terrible phylogenetic speculations totally disconnected from any plausible biological mechanism, as it is the case for example with regard to the various merging scenarios between archaebacteria and eubacteria to explain the origin of eukaryotes (Poole and Penny 2007; Forterre 2011). Philosophy of taxonomy has therefore serious consequences on the progress of phylogenetic research.

10.7. Evolutionist Solution

Could the phyletic arrangement of cladists still be the least bad option available? To argue that this is not the case I will try to briefly dispel the main criticism that has been formulated against evolutionary systematics, namely its alleged subjectivity and lack of reproducibility, or even its informational ambiguity (Hennig 1975). Thus, different evolutionists would supposedly produce different classifications because of the arbitrary emphasis they would put on a particular character. Yet it is well known that characters do not all have the same phylogenetic value. Some very labile ones cannot be used for example to define higher taxa. However, this criticism affects much more Linnaean essentialism rather than modern evolutionism which is based on *overall* similarity to delineate taxa on a phylogenetic tree. This overall similarity is sometimes accused of being an ill-defined concept, thus ignoring decades of development of pheneticism (Sneath 1995) and also deluding oneself about the profound phenetic nature of pattern cladism, and three-taxon analysis in particular (Farris & Kluge 1998; Marques 2005; Farris 2014).

Unlike cladists, the method of argumentation of classical evolutionists was not numerical. However, the presence of numerical values does not guarantee the scientificity of a discourse (otherwise numerology should be considered a science!). One can ask whether the criticisms against classical evolutionary systematics do not come from an illusion of precision due to the use of mathematical tools in cladistic analysis… Anyway, it is important to note that the practice of evolutionary systematics is no longer the same as it was during the first half of the twentieth century. In phylogenetics, it successfully integrated the tools of traditional (morphological) cladistic analysis and also Bayesian (molecular) statistical analysis (Stuessy 2013). Progress has also been made in the field of taxonomy. For example, a reinterpretation of the results of phylogenetics, especially discordant results (Zander 2014a), has allowed the delimitation of precise paraphyletic groups from certain types of heterocladies (Zander 2009). As another example, we could cite the statistical algorithm that has been successfully used so as to objectively delineate island divergent genera derived from continental ones (Stuessy et al. 2014). New tools such as patrocladistics have also been proposed to allow a more objective and more reproducible delineation of paraphyletic groups (Stuessy & König 2008; Stuessy & König 2009; Hörandl & Stuessy 2010). This latter method has for example been successfully applied to angiosperms (Willner et al. 2014) from the raw data of APGIII. This allows the representation of evolutionary theories as true phylogenetic trees (Zander 2014b; Zander 2014c; Zander 2014d) variously called caulograms, phylograms, Bessey's cactus, bubble or spindle diagrams.

Still, evolutionary classifications remain accused of not accurately representing phylogenies because it is not possible to infer phylogenetic relationships between taxa from a classification alone (Hennig 1975). For example it is not possible, from the classification of tetrapods into four classes (Amphibia, Reptilia, Aves, Mammalia), to deduce that birds and mammals are descended from reptiles and that they are themselves descended from amphibians. The phyletic arrangement, that is called a cladification, allows instead the immediate reconstruction of relations between sister clades (yet, as we have previously shown, these relations are *artificial*, i.e. not historically natural relationships but abstract kinships). In addition, this reasoning is based on the assumption that it is desirable to identify phylogeny with classification, which is not the case! A phylogenetic tree and a

classification are in fact two complementary representations of a same evolutionary theory: "they are different ways of abstracting from and representing biological relationships" (Cavalier-Smith 1998). A cladification is thus isomorphic to a cladogram whereas a classification is consistent with a phylogeny; both must be presented together.

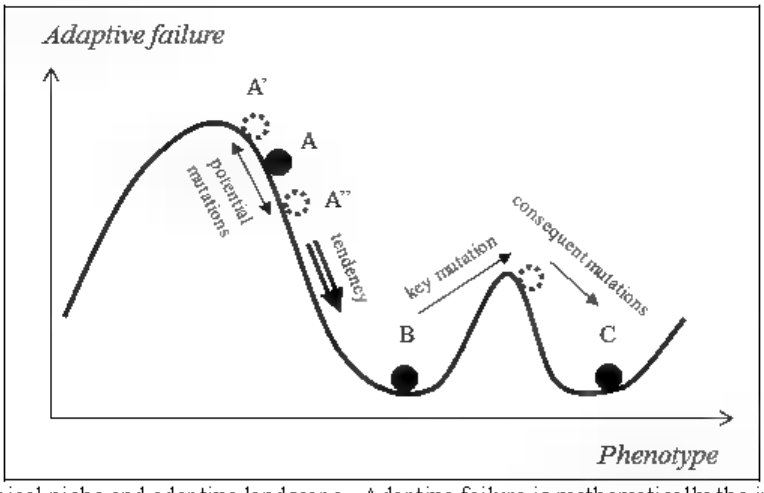

Figure 21. Ecological niche and adaptive landscape. Adaptive failure is mathematically the inverse of adaptive success, or *fitness*; it can be perceived as being analogous to potential energy in physics. Thus, although the phenotype of a species A can randomly evolve towards A' or A'', the better fitness of A'' indirectly causes the emergence of a trend towards an evolution into a depression of the adaptive landscape (ecological niche). A change of ecological niche generally requires the introduction of a key mutation, in the absence of which natural selection would have a stabilizing effect (B, evolutionary stasis). This mutation is not necessarily of extraordinary magnitude (macromutation), like key species in ecosystems, which are rarely the most abundant ones. The population who inherited this mutation then underwent directional selection that will make them reach a new evolutionary optimum (C). If cladogenesis occurs after the key mutation but before subsequent mutations, we will probably see the realization of a case of parallelophyly, a special case of polyphyly where phyletically very close species undergo evolutionary convergence (which explains by the way Vavilov's law of homologous series). It is also worth mentioning that the adaptive landscape is not immutable: its shape can change over time because of the interactions between a species and its niche, the interactions among different ecological niches or even because of a sudden catastrophe.

Ambiguity of information content in taxa is also attacked by cladists, who see this only disparate criteria concerning ecology, morphology or genetics. How to tell if two species were grouped in the same taxon a result of high genetic proximity or because they share the ecological niche? The kind of information that a user could draw from classification would therefore not be predictable. The predictive value of an evolutionary classification however relies precisely on its probabilistic nature. Blaming overall similarity for its inability to establish a guaranteed subset of characters shared by all members of a group is in fact a criticism from an *essentialist* perspective. In this sense, since groups defined by cladonomy are based on immutable synapomorphies, it is not difficult to argue that cladism is form of *historical essentialism* (Griffiths 1999; LaPorte 2004). It is by the way a kind of essentialism empirically refuted given potential reversions, which makes all things considered rather suspect the supposedly better predictability of phyletic arrangements. In any case, the accusation of unpredictability precisely rely on the (nominalist) belief that a classification cannot contain information other than those used in its development. But the goal of evolutionary systematics is indeed to infer new information from the collected data, not just to produce heterogeneous amalgam. This new information is of purely *phylogenetic* nature, it does not match any of the types of data that were used in its production. Only a dialectical thinking

can help us to understand the phenomenon of emergence, i.e. the fact that the whole (classification) cannot be reduced to the sum of its parts (raw data).

Then, phylogenetic information means that two species belong to the same taxon because of an evolutionary leap (a more or less great qualitative leap depending on its rank) that separates them from other species. This leap should not be understood in a metaphysical manner (macroevolution and microevolution are of the same nature!) but in a dialectical manner, i.e. it is the result of an accumulation of quantitative changes that allows us to describe the moving surface of the adaptive landscape with which organisms constantly interact (see Figure 21). So it makes no sense to evaluate a purely *phenetic* distance between two organisms regardless of their natural environment (which is the idealistic mark of pheneticism). Individual characters have to be weighted in terms of their evolutionary significance, which is itself a synthesis of their adaptive value and their evolutionary lability. This classification may be used as a support to explain life history thanks to the view it enables regarding *stasis* within niches and *revolutions* between niches through key innovations (which are not necessarily macromutations!) that give rise to new higher taxa. Classification does not directly represent the phylogeny (pattern), but in a sense leaps within phylogenesis (process).

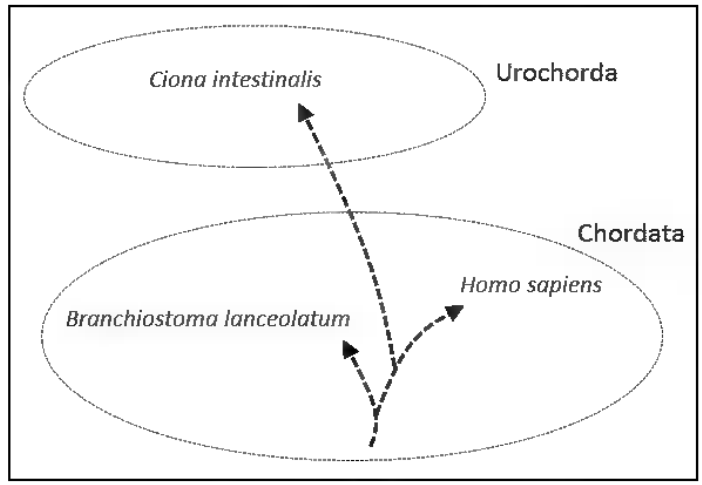

Figure 22. Phylogeny of three species of chordonians. Vertebrates have generally retained the ancestral body plan of cephalochordates while urochordates have radically changed according to ∎ sessile lifestyle. Time is not depicted. Drawn after the classification of Cavalier-Smith (1998).

Finally, I would like to illustrate a particular kind of subjectivity of which evolutionary systematics is accused: anthropocentrism. According to this thesis, cladism would be the only philosophy able of performing the "Copernican revolution" that shall depose man from the top of the evolutionary tree (Lecointre et al. 2008). The concept of *grade* (Huxley 1957; Huxley 1958; Huxley 1959; Cavalier-Smith 1998), largely used by evolutionists, would supposedly refers to the mediaeval notion of "chain of being" (or *Scala Naturæ*). Yet, evolutionism has broken away from Haeckel's and Lamarck's gradism since a long time ago! The concept of *grade of organization* simply refers either to overall similarity (classical evolutionism), or to adaptive zone (modern evolutionism). There is no superior or inferior grade in absolute terms, but only with respect to time. A simplification of body plan because of a shift to a parasitic lifestyle must therefore be understood as a change towards a superior (i.e. later) grade. It is also precisely in this manner that the concept of *grade of character* is perceived within the classical cladist paradigm (process cladism) when ancestral states are distinguished from derived states. In infrakingdom Chordonia (Cavalier-Smith 1998), the phylum Urochorda is therefore placed at the top of the tree instead of the phylum Chordata (to which man

belongs, see Figure 22). Ironically, placing man below yellow sea squirt is a much more drastic Copernican revolution than considering them equal!

CONCLUSION

Contrary to what some may think (Farris 1985), the problem of the meaning of the word "monophyly" is not a superficial terminological quarrel. Without an adequate scientific vocabulary it is unreasonable to hope to properly handle the concepts of systematics and their properties. I have shown that the term "monophyly" should be retained in its Haeckelian meaning firstly for a historical reason (it is its original meaning, see Section 2), secondly for a utilitarian reason (a term uniting both paraphyly and holophyly is indeed necessary, see Section 4) and thirdly for a morphosemantic reason (this meaning is the most consistent, see Section 5). Cladists may substitute the term "monophyly" by "holophyly" without the slightest drawback, so there is no need to continue the defence of the Hennigian meaning of "monophyly" if not solely to prevent evolutionists to express themselves!

My mathematical analysis has shown the many logical inconsistencies that dot the cladist practice, such as the inability to cut a holophyletic group into two holophyletic groups (Theorem 5.4). These theoretical flaws come from a defective philosophy that I identified as firmly nominalist and metaphysical (see Table 3), but fluctuating between materialism (process cladism) and idealism (pattern cladism). This combination is indicative of the influence that structuralism have had on the systematics (Zander 2011). Cladism is therefore unable to adequately reflect some empirical facts like the many paraphyletic extant species. Thus the assertion that no extant species is descended from another extant one is frankly dogmatic. In addition to its intrinsic taxonomic flaws, cladist philosophy leads to some abuses in the practice of phylogenetics. One may note for example the development of a kind of mysticism about horizontal gene transfer (HGT) that supposedly justifies the assertion that "there is no tree." Such a reasoning necessarily confuses genes with organisms that bears them, it is therefore a very rough reductionism (Valas & Bourne 2010). Evolutionism, unlike cladist paradigm, is characterized by a strongly realist and materialist philosophy, which is even dialectical in its most modern (i.e. quantitative) version. Far from being seen as a constraint that should be accommodated, paraphyly is at the heart of evolutionary mechanisms for evolutionism (Hörandl & Stuessy 2010; Hörandl 2014). However, the acceptance of a new way of doing things requires actual papers published using a convincing evolutionist methodology. That's why I will focus in the future on treating real data with the various methods proposed so far in order to test and find the best one, and let the other systematists to judge on results.

It is quite clear that cladism and evolutionism are in fact the modern heirs of two fundamental philosophies confronting each other since ancient times: respectively Eleaticism and Heracliteism. It would be vain to believe that a fight that lasted for 25 centuries can be suddenly completed. Regarding systematics, it would certainly be more advantageous to seek to develop neutral nomenclatural rules, flexible enough to be compatible with both schools, unlike the infamous *PhyloCode* (Keller et al. 2003; Rieppel 2006). Cladonomy (the naming of clades) practiced by cladists is not in itself incompatible with the existence of a parallel evolutionary classification. It becomes only so when cladists name their clades by reusing the nomina previously associated to taxa! It is understandable for example that cladists want to name the clade comprising bony fishes and tetrapods, but it is quite indefensible that they use for this the term Osteichthyes by claiming that bony fishes are paraphyletic (Brummitt 2006). However the use of a new word like euteleostomi avoids the unnecessary competition between clades and taxa for the same nomina. Similarly it would be incongruous to redefine the term Reptilia to encompass all amniotes.

The problem today is that the nomenclature is torn between three distinct codes for historical reasons, separately addressing zoology (Ride et al. 1999), botany (McNeill et al. 2012) and bacteriology (Lapage et al. 1992). This separation is frankly outdated and leads to fantastic nonsense,

such as the fact that a taxon may be treated by two competing codes and therefore receives two distinct scientific names (for example the phylum Euglenozoa = the division Euglenophyta, or the dinoflagellate class Syndinea = Syndiniophyceae) or else that some taxa may be formally treated by no code (for example bacterial taxa above the rank of class). This is why it is urgent that systematists finally endow a single nomenclatural code replacing the current three. This code should not be a simple synthesis of those old codes like the current draft *BioCode* (Greuter et al. 2011), but will have to embody a radical renovation of biological nomenclature assigning a special status to three types of groups: taxa, clades and grades. It is necessary to understand that these three concepts are not exclusive (Cavalier-Smith 1998), and that a biological group can, without contradiction, belong to zero, one, two or three of these categories. I therefore suggest the integration of the 8 following proposals to the next BioCode:

1. The recognition in preamble of the existence of three types of groups governed by the rules of the *BioCode*: taxa, clades and grades. This however is not the role of nomenclature to assign them a precise formal definition. For the sake of simplicity, scientific names of these groups should always be treated in local languages as proper nouns in the singular (even if their Latin number is plural). Example: "Plantae is a taxon" (notice the use of singular whereas *plantae* is a Latin plural).
2. Taxa are hierarchized within a *phylogenetic classification* (adjectives like "traditional" or "classical" should be avoided because they are often pejorative and have ideological connotations). They have a taxonomic rank that can be as high as empire (imperium) and as low as subvariety (subvarietas).
3. Clades do not have ranks (this should appeal to the original designers of the *PhyloCode*) and are nested within a *phyletic arrangement*. Some cladists who have examined this issue have agreed that their way of arranging organisms does not result in a classification *sensu stricto* (Griffiths 1974) and that cladograms were not genealogies (and therefore not phylogenies).
4. In order to visually distinguish microtaxonomy and macrotaxonomy, taxa of rank lower than or equal to genus must be written in italics, while those of rank strictly higher must be written in roman (upright). Examples: Mammalia (class), *Caenorhabditis* (genus).
5. If the delimitation of a clade or a grade does not match that of a taxon, it is necessary to coin a new name if one wants to formally designate this group. The use of a synapomorphy is usually seen as the best way to define a clade.
6. In order not to confuse on the one hand taxa, and on the other hand clades and grades that are not taxa (although clades and grades can be taxa), these latter shall neither be capitalized (which is unique to taxa of rank strictly higher than species) nor be written in italics (which should be specific to taxa of rank lower than or equal to genus) and their ending should not match a categorical suffix (like "-phyta", "-ales", "-idea" etc.). Examples: neomura, opisthokonta, corticata, euteleostomi, amniota, streptobionta.
7. The desire for taxonomic stability should be reaffirmed by explicitly prohibiting the use of paraphyly (or even simple heteroclady) as a pretext to change the delimitation of a taxon. It is an irrelevant criterion.
8. To facilitate the identification of paraphyletic groups, which are unsuitable for a phyletic arrangement or a cladistic analysis, they should always be followed by an asterisk if paraphyly is believed to be sufficiently proven (even if it is a cryptic one, as in the case of choanoflagellates). Examples: Osteichthyes*, Choanoflagellata*, Biliphyta* (paraphyletic taxa); pisces*, eubacteria* (grades that are neither taxa nor clades).

It has been proposed to exclude polyphyletic groups from the notion of grade (Willner et al. 2014), which may be relevant given that there is already a term, the word "phenon," that refers to overall similarity without any consideration for phylogeny. I am not sure, however, that this distinction truly has its place in the *BioCode*; that is why I have not included it in the above

suggestions, despite its merits. These few proposals, although quite drastic, nevertheless fit a continuation of nomenclatural tradition in seeking to promote stability, universality and flexibility. When cladism emerged, its advocates have criticized classical taxonomy for its authoritarianism. Cladists would therefore betray their noble ideals of freedom and transparency if they were going to continue to impose their recurring redefinitions of paraphyletic taxa to the rest of the scientific community. All of these 8 suggestions can be applied right now without waiting for a potential future integration to the *BioCode* since they do not contradict any of the rules of the current codes.

By following these proposals, cladists would be entirely free to continue to consider that only clades are natural, while evolutionists could freely think in terms of taxa without their definitions being modified each time that a study shows that they are paraphyletic: it would be sufficient to add an asterisk. Cladists would immediately know when reading an evolutionist paper that groups with an asterisk do not fundamentally interest them. Conversely, evolutionists would also know when reading a cladist paper that groups whose names are not capitalized (and not in italics) are not natural regarding their views. There would be no longer terminological dispute between the two schools, and both would be able to freely arguing about the merits and shortcomings of their respective philosophies and their scientific results. This is possible because, while divergent on formal classification, both schools have converged on the subject of phylogenetic inference (Stuessy 2013). Museums, conservation biologists, authors of textbooks and books, etc. would also be free to choose between *phylogenetic classification* and *phyletic arrangement*, the one deemed as the most appropriate to their practice or presentation of their comments. It would be foolish to refuse to turn the frontal opposition between cladists and evolutionists and the competition between clades and taxa for the same nomina, which has considerably hampered the progress of science for decades, into a mutually beneficial cooperation.

ACKNOWLEDGMENTS

I would like to sincerely acknowledge Richard Zander who made useful and encouraging comments on this work and suggested wise rectifications for a previous version of the manuscript.

ANNEXE: MATHEMATICAL PROOFS

Lemma 1.5:

The individual a being an ancestor of b, there exists a lineage $x_1, x_2, \ldots, x_n$ such that $n > 1$, $x_1 = a$, $x_n = b$, and $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq n-1$.

Likewise, b being an ancestor of c, there exists a lineage $x_n, x_{n+1}, \ldots, x_k$ such that $k > n$, $x_n = b$, $x_k = c$, and $(x_i, x_{i+1}) \in p$ for every i, $n \leq i \leq k-1$.

It exists therefore a sequence $x_1, x_2, \ldots, x_k$ such that $k > 2$, $x_1 = a$, $x_k = c$, and $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq k$. Thus, according to Definition 1.3, a is an ancestor of c. □

Lemma 1.6:

Let there be x and y such that $x \neq y$ and y is an ancestor of x. By definition, it exists a lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = y$, $x_n = x$ and, since $n \geq 2$, then $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq n-1$.

If we assume that x is an ancestor of y, then it exists a sequence $x_n, x_{n+1}, \ldots, x_k$ such that $x_n = x$, $x_k = y$ and, since $k > n$, then $(x_i, x_{i+1}) \in p$ for every i, $n \leq i \leq k-1$. It exists therefore a lineage $x_1, x_2, \ldots, x_k$ such that $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq k-1$. Yet $y = x_1 = x_k$ which is contradictory with the acyclicity of p. Therefore x cannot be an ancestor of y. □

Lemma 1.7:

Let there be $x \notin g$ such that a is an ancestor of x, then according to Definition 2.3 it exists a lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$, $x_n = x$, and $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq n-1$.

Let there be the proposition $\mathcal{P}(i)$ = "$x_i \in g$". We know that $\mathcal{P}(1)$ is true because $x_1 = a$ which belongs to g. Let there be the proposition Q = "it exists a pair $(x_i, x_{i+1}) \in p$ such that $x_i \in g$ and $x_{i+1} \notin g$". Now let us assume that Q is false, then for every pair $(x_i, x_{i+1}) \in p$, $x_i \notin g$ or $x_{i+1} \in g$.

If it is assumed that $\mathcal{P}(i)$ is true, then clearly $x_{i+1} \in g$, so $\mathcal{P}(i+1)$ is true. We deduce by the recurrence theorem that $\mathcal{P}(i)$ is true for every i, $1 \leq i \leq n$. Yet we know that $\mathcal{P}(n)$ is false since $x_n = x$ which does not belong to g. We conclude from this contradiction that Q cannot be false. □

Lemma 1.11:

Let us assume the existence of a second lineage $y_1, y_2, \ldots, y_k$ such that $y_1 = a$ et $y_k = x$. Let there be the proposition $\mathcal{P}(i)$ = "$x_{n-i} = y_{k-i}$" defined for every i, $0 \leq i \leq \min(n, k) - 1$.

Since $y_k = x_n = x$, it is clear that $\mathcal{P}(0)$ is true. Now let us assume that $\mathcal{P}(i)$ is true for a certain $i < \min(n, k) - 1$. Then, the network G being without mergings, it exists only one individual $z \in X$ such that $(z, x_{n-i}) \in p$, and since $x_{n-i} = y_{k-i}$ we also know that $(z, y_{k-i}) \in p$. Yet, it already exists x_{n-i-1} and y_{k-i-1} such that $(x_{n-i-1}, x_{n-i}) \in p$ and $(y_{k-i-1}, y_{k-i}) \in p$, which allows us to assert that $z = x_{n-i-1} = y_{k-i-1}$, and therefore that $\mathcal{P}(i+1)$ is true. We deduce by the recurrence theorem that $\mathcal{P}(i)$ is true for every i, $0 \leq i \leq \min(n, k) - 1$.

If we now assume that $n > k$, then $\mathcal{P}(k-1)$ = "$x_{n-k+1} = y_1$" is true. Yet, since $y_1 = x_1 = a$ then it must exist a lineage $x_1, \ldots, x_{n-k+1}$ such that $x_1 = x_{n-k+1} = a$, which is contradictory with the acyclicity of p by Definition 1.1. The same reasoning symmetrically applies if we conversely assume that $k > n$, forcing us to conclude that $k = n$. The lineage that connects x to its ancestor a is therefore unique. □

Theorem 1.12:

Let there be a genealogical network $G = (X, p)$ without mergings and the individuals $a, b, x, y \in X$ such that a is an ancestor of x and y, and b is an ancestor of x but not of y. By Lemma 2.11, it exists three unique lineages $(x_i)_{1 \leq i \leq n}$, $(x'_i)_{1 \leq i \leq p}$, and $(x''_i)_{1 \leq i \leq q}$ such that $x_1 = x'_1 = a$, $x''_1 = b$, $x_n = x''_q = x$ and $x'_p = y$.

Let there be the proposition $\mathcal{P}(i)$ = "$x_{n-i} = x''_{q-i}$" defined for i such that $0 \leq i \leq \min(n, q) - 1$. $\mathcal{P}(0)$ is trivially true. Let us now assume that $\mathcal{P}(i)$ is true for a certain $i < \min(n, q) - 1$. We know by definition that $(x_{n-(i+1)}, x_{n-i}) \in p$ and also that $(x''_{q-(i+1)}, x''_{q-i}) \in p$. Yet, G being a network without mergings, we can deduce that $x_{n-(i+1)} = x''_{q-(i+1)}$ and therefore that $\mathcal{P}(i+1)$ is true. By the recurrence theorem $\mathcal{P}(i)$ is therefore true for every i.

Let us now assume that $q \geq n$, then $\mathcal{P}(n-1)$ = "$x_1 = x''_{q-(n-1)}$", hence $x''_{q-(n-1)} = a$. Yet, b being an ancestor of $x''_{q-(n-1)}$, we deduce that b is an ancestor of a. The individual a, being itself an ancestor of y, we deduce that b is an ancestor of y, which is absurd. We are thus forced to conclude that $n > q$. In this case we know that $\mathcal{P}(q-1)$ = "$x_{n-(q-1)} = x''_1$". Yet $x''_1 = b$, and $x_1 = a$ is an ancestor of $x_{n-(q-1)}$, therefore a is an ancestor of b. □

Lemma 2.4:

Let there be a monophyletic group g and $a \in g$ a common ancestor of g. Let us assume that there exists an individual $a' \neq a$ such that $a' \in g$ and a' is a common ancestor of g. Since $a \in g$ then a' is an ancestor of a. By Lemma 1.6, a is not an ancestor of a'. But symmetrically, since $a' \in g$ and a is a common ancestor of g, then a is an ancestor of a', which is contradictory. A monophyletic group can therefore include only one common ancestor. Let us now assume that a is not a most recent common ancestor (cenancestor) of g, then there must exist another common ancestor a'' of g such that a is an ancestor of a''. However because $a \in g$, we must conclude that a'' is also an ancestor of a, which is again impossible by Lemma 1.6. □

Lemma 2.6:

The group g being continuous, it exists by Definition 2.5 at least one lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$, $x_n = x$ and $x_i \in g$ for every i, $1 \leq i \leq n$. By Lemma 1.11 there does not exist in X a second lineage $x'_1, x'_2, \ldots, x'_n$ such that $x'_1 = a$ and $x'_n = x$. □

Lemma 2.7:

Let us assume there exist two distinct individuals a, $a' \in X$ most recent common ancestors of g. There exist therefore $x \in g$ such that a and a' are ancestors of x. The network G being without mergings, a being an ancestor of itself, and a' being not an ancestor of a by Definition 2.2, we must conclude by Theorem 1.12 that a is an ancestor of a', which is impossible. □

Lemma 3.5:

Let us name a_2 and a_3 respectively the included common ancestors of g_2 and g_3. The group g_2 being ancestral to g_3, there exist an individual $x_2 \in g_2$ such that x_2 is an ancestor of a_3. Since $x_2 \in g_2$, a_2 is an ancestor of x_2. The group g_1 being ancestral to g_2, there exist an individual $x_1 \in g_1$ such that x_1 is an ancestor of a_2. By Lemma 1.5, x_1 is an ancestor of a_3, therefore g_1 is ancestral to g_3. □

Theorem 3.6:

($\Leftarrow$) Let there be g_1 and g_2 two monophyletic groups such that g_1 is ancestral to g_2 and $g_1 \cap g_2 = \emptyset$. Let also be $g = g_1 \cup g_2$. Let us name a_1 the unique included common ancestor of g_1, and a_2 the one of g_2. There exists by definition a certain $x \in g_1$ such that x is an ancestor of a_2.

For every $y \in g$, $y \in g_1$ or else $y \in g_2$. In the first case, a_1 is by definition an ancestor of y. In the second case, we know that a_1 is an ancestor of x, that x is an ancestor of a_2, and that a_2 is an ancestor of y. By Lemma 1.5, we deduce that a_1 is an ancestor of y. The individual a_1 is therefore the unique included common ancestor of g. This group is therefore monophyletic. The reasoning is symmetrical if we would have chosen that g_2 is ancestral to g_1.

($\Rightarrow$) Let there be g_1 and g_2 two monophyletic groups such that $g_1 \cap g_2 = \emptyset$. Let also be $g = g_1 \cup g_2$ a monophyletic group. Let us name a_1, a_2, and a the respective included common ancestors of g_1, g_2 and g. Then, either $a \in g_1$ or $a \in g_2$. Let us choose $a \in g_1$. We know by definition that a is an ancestor of x for every $x \in g$. In particular $a_2 \in g$, so a is an ancestor of a_2. Therefore g_1 is ancestral to g_2. Symmetrically if we would have chosen $a \in g_2$, we would then have to conclude that a is an ancestor of a_1 and therefore that g_2 is ancestral to g_1. □

Theorem 3.7:

($\Leftarrow$) Let there be g_1 and g_2 two continuous groups such that g_1 is directly ancestral to g_2 (again, g_1 and g_2 have symmetrical roles), and $g = g_1 \cup g_2$. Let us name a_1 the unique included common ancestor of g_1 and a_2 the unique included common ancestor of g_2.

For every $y \in g$, either $y \in g_1$ or $y \in g_2$. If $y \in g_1$ then, since g_1 is continuous, it exists a lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$, $x_n = x$, and if $n > 1$ then for every i, $1 \leq i \leq n-1$, $x_i \in g_1 \subset g$ and $(x_i, x_{i+1}) \in p$.

Conversely, let us now consider the case $y \in g_2$. The group g_1 being directly ancestral to g_2, it exists a certain $x \in g_1$ such that $(x, a_2) \in p$. The group g_1 being continuous, there exists a lineage $x_1, x_2, \ldots, x_m$ such that $x_1 = a_1$, $x_m = x$, and if $m > 1$ then for every i, $1 \leq i \leq m-1$, $x_i \in g_1 \subset g$ and $(x_i, x_{i+1}) \in p$. Since g_2 is continuous, it exists a lineage $x_{m+1}, x_{m+2}, \ldots, x_n$ such that $x_{m+1} = a_2$, $x_n = y$, and if $n - m > 1$ then for every i, $m+1 \leq i \leq n-1$, $x_i \in g_2 \subset g$ and $(x_i, x_{i+1}) \in p$. We thus deduce that for every $y \in g_2$ it exists a sequence $x_1, x_2, \ldots, x_{m+n}$ such that $x_1 = a_1$, $x_{m+n} = y$, and since $m + n > 1$ then for every i, $1 \leq i \leq m+n-1$, it is true that $x_i \in g$ and $(x_i, x_{i+1}) \in p$. The group g is therefore continuous.

($\Rightarrow$) Let there be g_1 and g_2 two continuous groups such that $g_1 \cap g_2 = \emptyset$. Let there be also the continuous group $g = g_1 \cup g_2$. Let us name a the unique included common ancestor of g. For every

$x \in g$, either $x \in g_1$ or $x \in g_2$. Let us assume that $a \in g_1$ (the reasoning is symmetrical if we choose $a \in g_2$).

By definition, for every $y \in g$ it exists a lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$, $x_n = y$, and if $n \geq 2$ then $x_i \in g$ and $(x_i, x_{i+1}) \in p$ for every i, $1 \leq i \leq n-1$. Let us choose $y \in g_2$.

Let there be the simple proposition $\mathcal{P}(i)$ = "$x_i \in g_1$". We know that $\mathcal{P}(1)$ is true because $x_1 = a \in g_1$. Let there be the proposition Q = "it exists a pair $(x_i, x_{i+1}) \in p$ such that $x_i \in g_1$ and $x_{i+1} \in g_2$."

Let us assume that Q is false, then for every pair $(x_i, x_{i+1}) \in p$ of this lineage, $x_i \in g_2$ or $x_{i+1} \in g_1$. If we assume that $\mathcal{P}(i)$ is true then clearly $x_i \notin g_2$, so $x_{i+1} \in g_1$, therefore $\mathcal{P}(i+1)$ is true. We deduce by the recurrence theorem that $\mathcal{P}(i)$ is true for every i, $1 \leq i \leq n$. However, we know that $\mathcal{P}(n)$ is false since $x_n = y \notin g_1$. We deduce from this contradiction that Q cannot be false.

Let us name (x, x') one such of these pairs, so that $x \in g_1$ and $x' \in g_2$. Let us consider the case $y = a_2$, since x' belongs to the lineage leading to y, then x' is an ancestor of a_2. But since $x' \in g_2$ we know that a_2 is also an ancestor of x'. We deduce by Lemma 1.6 that $a_2 = x'$. It exists therefore a certain $x \in g_1$ such that $(x, a_2) \in p$. Thus, the group g_1 is directly ancestral to g_2. □

Lemma 4.3:

Let there be a monophyletic group g and a its (included) cenancestor.

($\Rightarrow$) If g is paraphyletic, then there exists by definition a pair $(b, x) \in p$ such that $b \in g$ and $x \notin g$. The individual a is an ancestor of b since $b \in g$, so by Lemma 1.6, a is an ancestor of $x \notin g$.

If g is holophyletic, then by definition there does not exist a pair $(b, x) \in p$ such that $b \in g$ and $x \notin g$. But let us assume that there exists $y \notin g$ such that a is an ancestor of y. Then by Lemma 1.7 for every lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$ and $x_n = y$, it exists a certain i, $1 \leq i \leq n-1$, such that $x_i \in g$ and $x_{i+1} \notin g$. This clearly contradicts the definition of holophyly, therefore it does not exist $y \notin g$ such that a is an ancestor of y.

($\Leftarrow$) Let there be $x \notin g$ such that a is an ancestor of x, then by Lemma 1.7 for every lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a$ and $x_n = x$, it exists a certain i, $1 \leq i \leq n-1$, such that $x_i \in g$ and $x_{i+1} \notin g$. The group g is therefore paraphyletic.

Conversely, let us assume that for every $y \in X$, if a is an ancestor of y then $y \in g$. But let us also assume that there exists a pair $(x, y) \in p$ such that $x \in g$ and $y \notin g$. Since $x \in g$, a is an ancestor of x, which is an ancestor of y. So by Lemma 1.5, a is an ancestor of $y \notin g$. This is clearly contradictory, therefore it does not exist any pair $(x, y) \in p$ such that $x \in g$ and $y \notin g$, so g is holophyletic. □

Lemma 4.6:

Let there be a group g and $A \neq \emptyset$ the set of all the most recent common ancestors of g.

($\Rightarrow$) If g is heterophyletic then for every $a \in A$, there exists $x \in X$ such that a is an ancestor of x and $x \notin g$. Let us assume that there exists $a \in A$ such that $a \in g$ then by Lemma 2.4, a is the unique included common ancestor of a. Thus, it exists $x \in X$ such that a is an ancestor of x and $x \notin g$, therefore by Lemma 4.3, g is paraphyletic. Conversely, let us now assume that $a \notin g$ for every $a \in A$, then by Definition 4.4, g is polyphyletic.

($\Leftarrow$) If g is paraphyletic then by Lemma 2.4 it exists exactly one $a \in A$ such that $a \in g$. By Lemma 4.3, it exists $x \notin g$ such that a is an ancestor of x. The group g is thus heterophyletic.

If g is polyphyletic then $a \notin g$ for every $a \in A$. Yet, for every $a \in A$, a is a trivial ancestor of a. We deduce from this that g is heterophyletic. □

Lemma 5.2:

Let there be a group g whose elements are called $x_1, x_2, \ldots, x_n$. The set $\{\{x_1\}, \{x_2\}, \ldots, \{x_n\}\}$ is a continuous partition of g since firstly for every i, $1 \leq i \leq n$, $\{x_i\} \neq \emptyset$ and $\{x_i\}$ is a trivial continuous group; secondly if $n \geq 2$ then for every i, j, $1 \leq i < j \leq n$, $\{x_i\} \cap \{x_j\} = \emptyset$; and thirdly $\bigcup_{1 \leq i \leq n} \{x_i\} = g$.

Let us now assume that there exists a continuous partition $\{g_1, g_2, \ldots, g_k\}$ having a number of elements k strictly superior to n, the number of elements of g. For every i, $1 \leq i \leq n$, $g_i \neq \emptyset$, therefore $\mathrm{card}(g_i) \geq 1$. Since for every i, j, $1 \leq i < j \leq k$, $g_i \cap g_j = \emptyset$, we have $\mathrm{card}(\bigcup_{1 \leq i \leq k} g_i) \geq k$. Yet, $\bigcup_{1 \leq i \leq k} g_i = g$ and $\mathrm{card}(g) = n < k$. From this contradiction we conclude that there does not exist a continuous partition having a number of elements strictly superior to the number of elements of g. □

Theorem 5.4:

Let us name a the unique included common ancestor of g. Then it exists a certain i, $1 \leq i \leq n$, such that $a \in g_i$. For every $j \neq i$, $1 \leq j \leq n$, and for every $x \in g_j$ we know that a is an ancestor of x since $x \in g$. Yet $x \notin g_i$, therefore by Lemma 4.3 we conclude that g_i is paraphyletic. □

Theorem 5.7:

Let us assume that there exists a continuous partition $K' = \{g'_1, g'_2, \ldots, g'_n\}$ such that $\mathrm{card}(K') = n$ and $K \neq K'$. That is to say, there exists at least one i, $1 \leq i \leq n$, such that for every j, $1 \leq j \leq n$, $g_i \neq g'_j$. Let there be such a group g_i, and let us name a_i the unique included common ancestor of g_i. There exists a certain j, $1 \leq j \leq n$, such that $a_i \in g'_j$. We know by definition that $g_i \neq g'_j$ therefore it exists a certain $x \neq a_i$ such that $x \in g_i$ and $x \notin g'_j$ or else $x \notin g_i$ and $x \in g'_j$.

The reasoning is symmetrical in both cases. Let us assume that $x \in g_i$ and $x \notin g'_j$, then by Lemma 1.7, there exists a lineage $x_1, x_2, \ldots, x_n$ such that $x_1 = a_i$, $x_n = x$, and also a certain u, with $1 \leq u \leq n - 1$, such that $x_u \in g'_j$ and $x_{u+1} \notin g'_j$. The group g_i being continuous and without mergings, then by Lemma 2.6 this lineage is unique. Since $a_i \in g_i$, $x \in g_i$, and g_i is continuous, then by Definition 2.5, for every u, $1 \leq u \leq n$, $x_u \in g_i$. As a result, it exists $b, c \in g_i$ such that $(b, c) \in p$, $b \in g'_j$ and $c \notin g'_j$.

Now let us name g'_k the group of K' such that $c \in g'_k$ and a'_k the unique included common ancestor of g'_k. The individual a'_k is therefore an ancestor of c, and it exists a lineage $x'_1, x'_2, \ldots, x'_m$ such that $x'_1 = a'_k$, $x'_m = c$ and for every u, $1 \leq u \leq m$, $x'_u \in g'_k$. It we assume that $m \geq 2$, then the group g'_k being without mergings, it exists a unique x'_{m-1} such that $(x'_{m-1}, x'_m) \in p$. We know that $(b, x'_m) \in p$ therefore $b = x'_{m-1}$. Yet $b \notin g'_k$ although $x'_{m-1} \in g'_k$. We deduce from this contradiction that $m = 1$, therefore $c = a'_k$. The group g'_j is consequently directly ancestral to g'_k. By Theorem 3.7, the union $g'_j \cup g'_k$ is a continuous group. Therefore it exists a continuous partition K'' of g with cardinal $n - 1$, which contradicts the premise. Thus, we must conclude that there does not exist a continuous partition K' of g such that $\mathrm{card}(K') = n$ and $K \neq K'$. □

Theorem 6.2:

It is clear by Lemma 5.2 that any genealogical network can be transformed into a phylogenetic network. To show that these two types of networks are in fact the same, it is enough to show that p' is acyclic like p.

Let there be a sequence of continuous groups $g_1, g_2, \ldots, g_n$ such that $n \geq 2$ and $(g_i, g_{i+1}) \in p'$ for every i, $1 \leq i \leq n - 1$. By Lemma 3.5, g_1 is ancestral to g_n. Let us name a_1 and a_n the respective cenancestors of g_1 and g_n. Then it exists a certain $x \in g_1$ such that x is an ancestor of a_n. Since $x \in g_1$, then we know that a_1 is an ancestor of x, so by Lemma 1.5 a_1 is an ancestor of a_n.

Let us now assume that $g_1 = g_n$. Then $a_1 = a_n$. Therefore it exists a lineage $x_1, x_2, \ldots, x_n$ such that $a_1 = x_1 = x_n = a_n$. This contradicts the fact that p is acyclic on X. Since it is consequently impossible that $g_1 = g_n$, then p' must be acyclic on X'. □

Lemma 7.5:

Let there be a the unique included common ancestor of g'. Then we know that a is a common ancestor of g. For every $x \in g$, a is therefore an ancestor of x. By Lemma 4.3, g' is not holophyletic if $x \notin g'$, therefore we deduce that for every $x \in g$ we have $x \in g'$, so $g \subset g'$. The converse is false since we know that it is possible that $a \notin g$. □

Lemma 7.11:

Since g^* is monophyletic here, then there exists by Lemma 3.4 a unique common ancestor of g^* called a^*. Let us assume that $a^* \in A^*$, then there exists a certain $g'_h \in H$ such that a^* is the included common ancestor of g'_h, therefore $g^* \subset g'_h$, which means that for any $x \in g^*$ we know that $x \in g'_h$. Yet, by definition for every $x \in g^*$ we know that $x \notin g'_k$, so we deduce that $g'_h \cap g'_k = \emptyset$. Yet by Lemma 7.5, $g \subset g'_h$ and $g \subset g'_k$, therefore $g = \emptyset$, which is absurd. Thus, it is impossible that $a^* \in A^*$. □

Lemma 7.12:

Let there be g a clade in K, a an exclusive and most recent common ancestor of g, g' a canonical holophyletic group of g such that a is the unique included common ancestor of g', g'' the non-empty basal group of g relatively to g'.

By definition a is the unique included common ancestor of g'', thus making it a monophyletic group. By Observation 7.9, there exists a certain $x \in g$ such that $x \notin g''$. Yet, for any $x \in g$, a is an ancestor of x, therefore g'' is paraphyletic. □

Lemma 7.13:

Let there be g a clade in K, A the set of all the common ancestors of g, A' the set of all the exclusive common ancestors of g in K, $H = \{g'_1, g'_2, \ldots, g'_n\}$ the set of all the holophyletic groups canonically associated to g, and g^* a stem-group of g relatively to a certain $g'_k \in H$ whose cenancestor is also a cenancestor of g. Let us name a'_i the included common ancestors of g'_i.

If the set of all the common ancestors of g^* is empty then by Definition 4.4 g^* is polyphyletic and therefore heterophyletic. Now let us assume that a^*, a common ancestor of g^*, exists. Then a^* is an ancestor of at least some a'_i, which are all ancestors of every $x \in g$. By Lemma 1.5 a^* is therefore an ancestor of every $x \in g$. By Lemma 7.5, $g \subset g'_i$ for every i, $1 \leq i \leq n$. Yet by definition for every $x \in g'_k$ we know that $x \notin g^*$, thus $g^* \cap g = \emptyset$. Therefore it exists a certain $x \notin g^*$ such that a^* is an ancestor of x. So by Definition 4.5 g^* is heterophyletic, and more precisely paraphyletic if $a^* \in g^*$. □

Theorem 8.3:

Let there be g a clade in K and the set $\{g_1, g_2\}$ a cladistic partition of g. Let us assume that there exists a second cladistic partition $\{g_3, g_4\}$. Let there be a_1, a_2, a_3 and a_4 the exclusive common ancestors of respectively g_1, g_2, g_3 and g_4. Whatever $x \in g$ we know that $x \in g_1$ or else $x \in g_2$, and also $x \in g_3$ or else $x \in g_4$. If we assume that $g_1 \neq g_3$ (and $g_1 \neq g_4$), then there exist $x, y \in g_1$ (or else $x, y \in g_2$) such that $x \in g_3$ and $y \in g_4$.

In the first case this means that a_1 (or else a_2) is an ancestor of x and y, and that a_3 is an ancestor of x but not of y. Since the network is without mergings then we can deduce by Lemma 1.11 that a_1 (or else a_2) is an ancestor of a_3. Symmetrically, a_1 (or else a_2) is an ancestor of x and y whereas a_4 is an ancestor of y but not of x, which implies in the same way that a_1 (or else a_2) is an ancestor of a_4. Therefore for every $x \in g_3$ we have $x \in g_1$, and also for every $x \in g_4$ we have $x \in g_1$. Yet, since $g_3 \cup g_4 = g$, then for every $x \in g$ we have $x \in g_1$. There exists therefore no $x \in g$ such that $x \in g_2$, so $g_2 = \emptyset$, which is absurd. □

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Mohlenbrock, R.H. 2015. Validation of new combinations of vascular plants. Phytoneuron 2015-67: 1–3. Published 9 December 2015. ISSN 2153 733X

VALIDATION OF NEW COMBINATIONS OF VASCULAR PLANTS

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ABSTRACT

During the past five years I have made incorrectly new combinations of vascular plants in the state of Illinois because I failed to indicate the publication data for the basionyms. This paper validates these new combinations by listing the publication data for the basionyms.

Since 2011 I have published several new combinations of vascular plants in Illinois without citing the publication data of the basionyms. Validations for these new combinations are given below, along with the publication data for the combinations I proposed without indicating the publication data of the basionym.

ASTERACEAE

Eurybia chasei (G.N. Jones) Mohlenbr., **comb. nov.** Basionym: *Aster chasei* G.N. Jones, Vascular Pl. Illinois, 466. 1955.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 126. 2014.

Nabalus racemosus (Michx.) Hook. var. **multiflorus** (Cronq.) Mohlenbr., **comb. nov.** Basionym: *Prenanthes racemosa* Michx. subsp. *multiflora* Cronq., Rhodora 50: 30. 1948.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 138. 2014.

Packera paupercula (Michx.) A. Love & D. Love var. **balsamitae** (Muhl. ex. Willd.) Mohlenbr., **comb. nov.** Basionym: *Senecio balsamitae* Muhl. ex Willd., Sp. Pl. 3: 1998. 1803.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 499. 2014.

Symphyotrichum concinnum (Willd.) Mohlenbr., **comb. nov.** Basionym: *Aster concinnus* Willd., Enum. Pl. 2: 884. 1809.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 150. 2014.

Symphyotrichum oolentangiense (Riddell) G.L. Nesom var. **laevicaule** (Fern.) Mohlenbr., **comb. nov.** Basionym: *Aster azureus* Lindl. f. *laevicaulis* Fern., Rhodora 51: 94. 1949.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 152. 2014.

Symphyotrichum patentissimum (Lindl. ex DC.) Mohlenbr., **comb. nov.** Basionym: *Aster patentissimus* Lindl. ex DC., Prodr. 5: 232. 1836.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 152. 2014.

BRASSICACEAE

Boechera dentata (Raf.) Al-Shehbaz var. **phalacrocarpa** (M. Hopkins) Mohlenbr., **comb. nov.** Basionym: *Arabis dentata* Raf. var. *phalacrocarpa* M. Hopkins, Rhodora 39: 169. 1937.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 167. 2014.

CAMPANULACEAE

Campanulastrum americanum (L.) Small var. **illinoense** (Fresen.) Mohlenbr., **comb. nov.** Basionym: *Campanula illinoensis* Fresen., Index Sem. Frankfurt 1836.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 178. 2014.

CORNACEAE

Cornus sericea L. var. **baileyi** (Coult. & Evans) Mohlenbr., **comb. nov.** Basionym: *Cornus baileyi* Coult. & Evans, Bot. Gaz. 15: 37. 1890.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 205. 2014.

CYPERACEAE

Carex macropoda (Fern.) Mohlenbr., **comb. nov.** Basionym: *Carex digitalis* Willd. var. *macropoda* Fern., Rhodora 40: 400. 1938.

This was first published without basionym publication data in Ill. Flora Illinois, Sedges: *Carex*, ed. 2, 401. 2011.

Carex sangamonensis (Clokey) Mohlenbr., **comb. nov.** Basionym: *Carex tribuloides* Wahl. var. *sangamonensis* Clokey, Rhodora 21: 84. 1919.

This was first published without basionym publication data in Ill. Fl. Illinois, Sedges: *Carex*, ed. 2, 359. 2011.

Carex siccata Dewey var. **enervis** (Evans & Mohlenbr.) Mohlenbr., **comb. nov.** Basionym: *Carex foenea* Willd. var. *enervis* Evans & Mohlenbr., Trans. Ill. State Acad. Sci. 64: 270. 1971.

This was first published without basionym publication data in Ill. Fl. Illinois, Sedges: *Carex*, ed. 2, 339. 2011.

ERICACEAE

Vaccinium pallidum Ait. var. **crinitum** (Fern.) Mohlenbr., **comb. nov.** Basionym: *Vaccinium vacillans* Kalm ex Torr. var. *crinitum* Fern., Rhodora 13: 236. 1911.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 194. 2014.

LAMIACEAE

Stachys pilosa Nutt. var. **homotricha** (Fern.) Mohlenbr., **comb. nov.** Basionym: *Stachys palustris* L. var. *homotricha* Fern., Rhodora 10: 95. 1908.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 240. 2014.

POACEAE

Coleataenia condensa (Nash) Mohlenbr., **comb. nov.** Basionym: *Panicum condensum* Nash, Fl. S.E.U.S., 93. 1903.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 452. 2014.

Dichanthelium albemarlense (Nash) Mohlenbr., **comb. nov.** Basionym: *Panicum albemarlense* Nash, J. Elisha Mitchell Sci. Soc. 16: 84. 1900.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 457. 2014.

Dichanthelium helleri (Nash) Mohlenbr., **comb. nov.** Basionym: *Panicum helleri* Nash, Bull. Torrey Club 26: 572. 1899.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 457. 2014.

Dichanthelium pseudopubescens (Nash) Mohlenbr., **comb. nov.** Basionym: *Panicum pseudopubescens* Nash, Bull. Torrey Club 26: 577. 1899.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 458. 2014.

POLYGONACEAE

Persicaria hydropiperoides (Michx.) Small var. **bushiana** (Stanford) Mohlenbr., **comb. nov.** Basionym: *Polygonum hydropiperoides* Michx. var. *bushianum* Stanford, Rhodora 28: 27. 1926.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 501. 2014.

RHAMNACEAE

Frangula alnus Muhl. var. **angustifolia** (Loud.) Mohlenbr., **comb. nov.** Basionym: *Rhamnus frangula* L. var. *angustifolia* Loud., Encycl. Trees & Shrubs. 1842.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 307. 2014.

Frangula caroliniana (Walt.) Gray var. **mollis** (Fern.) Mohlenbr., **comb. nov.** Basionym: *Rhamnus caroliniana* Walt. var. *mollis* Fern., Rhodora 12: 79. 1910.

This was first published without basionym publication data in Vasc. Fl. Illinois, ed. 4, 307. 2014.

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Pruski, J.F., Mesfin Tadesse, and D.J. Crawford. 2015. Studies of Neotropical Compositae–XI. The new generic name *Electranthera* (Coreopsideae). Phytoneuron 2015-68: 1–17. Published 9 December 2015. ISSN 2153 733X

STUDIES OF NEOTROPICAL COMPOSITAE–XI. THE NEW GENERIC NAME *ELECTRANTHERA* (COREOPSIDEAE)

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ABSTRACT

Electranthera Mesfin, Crawford, & Pruski (Compositae: Coreopsideae), a shrubby, pistillate-rayed segregate of typically herbaceous, sterile-rayed *Coreopsis*, is a new generic name and replaces illegitimate *Electra* DC. 1836 (non *Electra* Panz. 1813, Gramineae). Three new combinations at species rank are proposed: ***Electranthera cuneifolia*** (Greenm.) Mesfin, Crawford, & Pruski, **comb. nov.**, ***Electranthera mutica*** (DC.) Mesfin, Crawford, & Pruski, **comb. nov.** (with ten varieties and nine new varietal combinations), and ***Electranthera parvifolia*** (S.F. Blake) Mesfin, Crawford, & Pruski, **comb. nov.** The type locality of *Coreopsis mutica* (≡ *Electranthera mutica*) was given by Keerl as "ad Tlapujahua" [near the Michoacán border with Mexico], but a type locality of somewhere in southern Hidalgo or adjacent Puebla seems more plausible.

Shrubby, pistillate-rayed *Electra* DC. (Compositae: Coreopsideae) was resurrected from synonymy with typically herbaceous, sterile-rayed *Coreopsis* L. by Mesfin Tadesse and Crawford (2014). That *Electra* DC. is an illegitimate later homonym of *Electra* Panz. 1813 (Gramineae), however, has escaped our attention until now. *Electra* Panz. was treated as valid, for example, in Sprengel (1817), Pfeiffer (1874), Jackson (1893), Davidse (2003), and *Index Nominum Genericorum* (Farr et al. 1979). The main purpose of this paper is to propose a new generic replacement name for *Electra* DC., for which we coin the alphabetically adjacent *Electranthera* Mesfin, Crawford, & Pruski.

Candolle (1836) described *Electra* as monotypic and simultaneously also named *Coreopsis mutica* DC. Gray (1852) described a second species of *Electra* and noted that inner disk florets of the genus do not always appear to set seed. Bentham and Hooker (1873) and Hemsley (1881) each treated *Electra* in synonymy with *Coreopsis*. *Electranthera* was treated at sectional rank as *Coreopsis* sect. *Electra* S.F. Blake by Blake (1913, 1917, 1924), Sherff (1936), Sherff and Alexander (1955), Crawford (1970, 1976, 1982), Crawford and Smith (1983), Jansen et al. (1987), and Mesfin Tadesse and Crawford (1995). The floras by Blake et al. (1926) and Turner (2010) treated *Coreopsis* without using infragenera and with *Electra* in synonymy.

Blake (1913, 1917) circumscribed *Coreopsis* sect. *Electra* as containing three species, but Blake (1924) referred additionally Hispaniolan *C. buchii* (Urb.) S.F. Blake to this section. Blake (1913) recognized *C. mexicana* (DC.) Hemsl. but quickly (Blake 1917) reduced it to synonymy with *C. mutica*, thus establishing priority of *C. mutica* over *Electra mexicana*. Sherff (1936) and Sherff

and Alexander (1955) followed Blake (1924) by recognizing these four species in *Coreopsis* sect. *Electra*. *Coreopsis buchii* was excluded from sect. *Electra* by Smith (1975) and Crawford (1976) and more recently treated as the sole species of obviously pappose *Selleophytum* Urb. by Kimball and Crawford (2004), Mort et al. (2008), Mesfin Tadesse and Crawford (2006, 2014), and Pruski (2015).

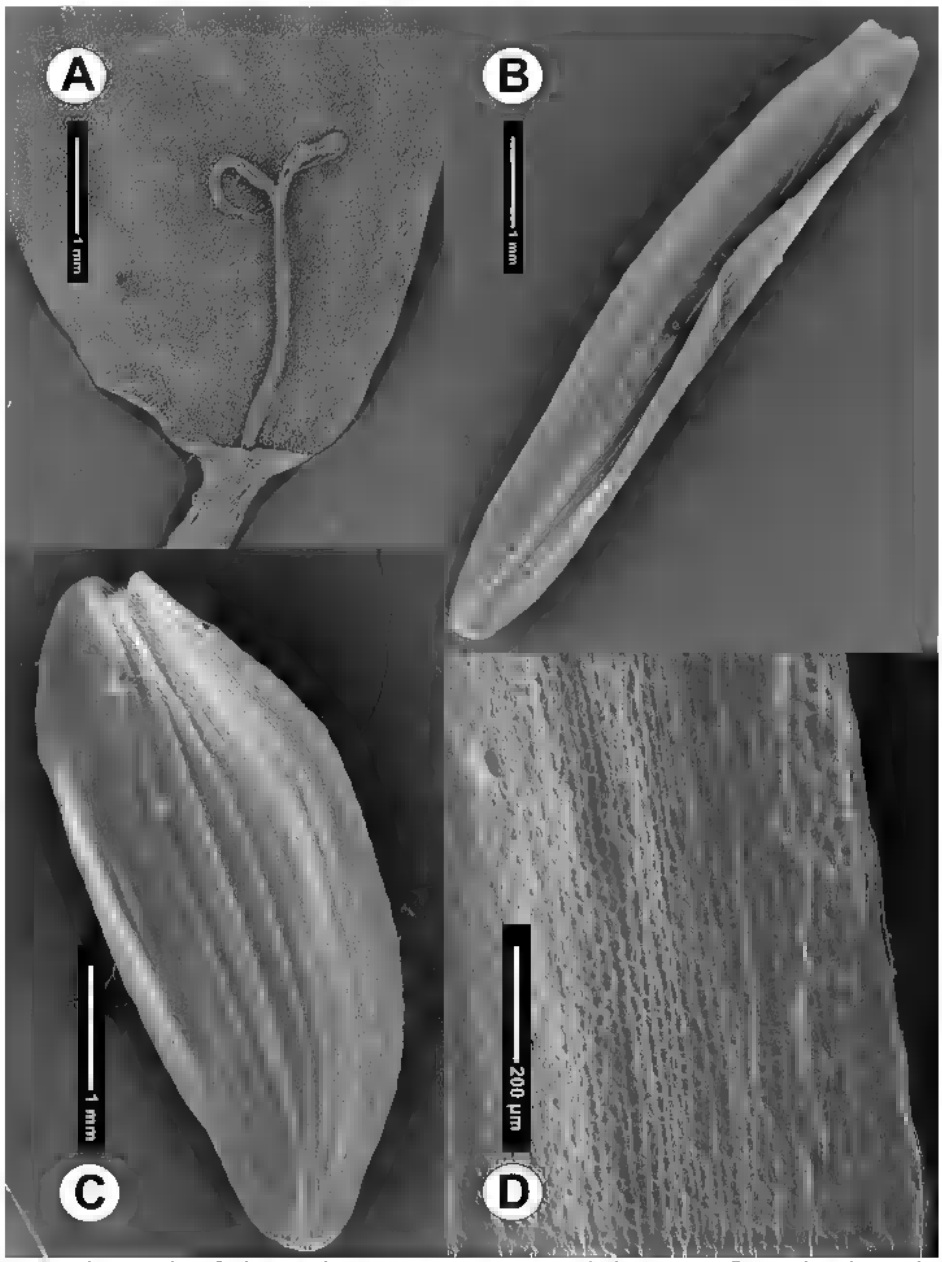

Figure 1. SEM micrographs of *Electranthera mutica* var. *microcephala*. A. Ray floret, showing style and adaxially strongly papillose corolla limb. B. Inner disk cypsela (adaxial view). C. Outer disk cypsela (abaxial view) showing the emarginate apex. D. Outer disk cypsela (close-up of C) on the left and in the center showing Type A (Mesfin Tadesse & Crawford 2014) pericarp surface ornamentation pattern with both radial and tangential walls thickened by unidentified dark secretions and the epidermis surface slightly raised, and ▪ the right the larger cells of the pale narrow lateral margins. (A from *Cronquist 9675*, MO; B–D from *Castillo 1632*, MO; sample preparation method is ▪ given in Pruski 2012).

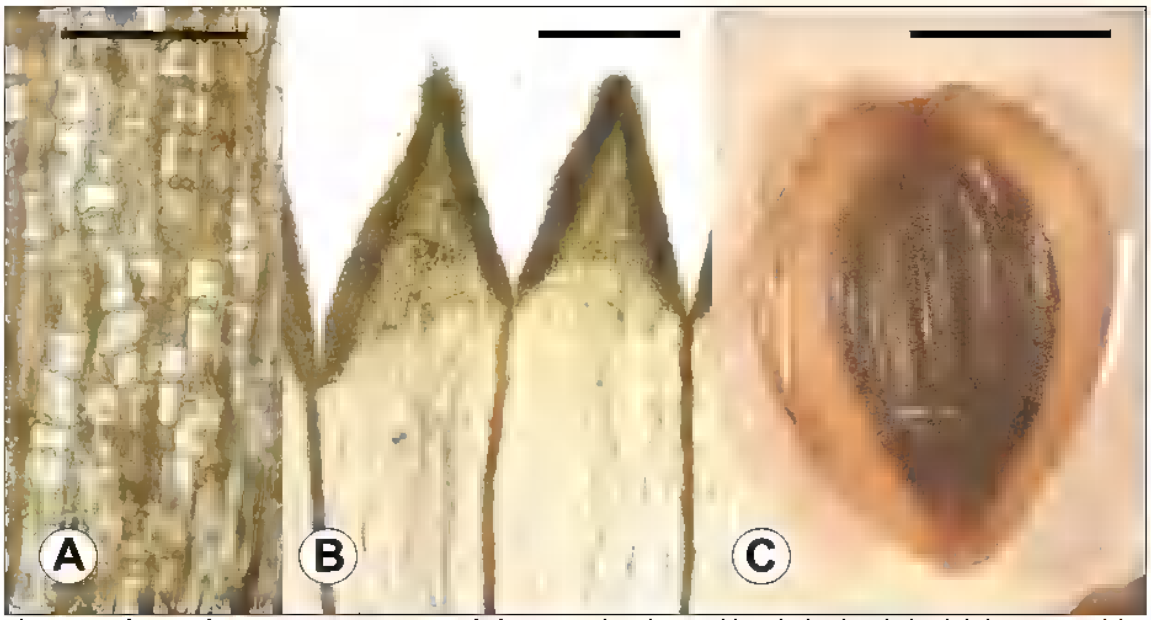

Figure 2. *Electranthera mutica* var. *microcephala*. A. Anther theca with polarized endothecial tissue. B. Disk corolla showing resin ducts single along the veins in the throat. C. Ray cypsela (abaxial view) showing dark but non-carbonized body and thin pale lateral wings. All from *Castillo 1632*, MO. [Scale bars: A 40 µm; B 0.5 mm; C 2 mm].

In resurrecting *Electra* from synonymy with *Coreopsis*, Mesfin Tadesse and Crawford (2014) provided a generic key and noted that *Coreopsis* sect. *Electra* (here *Electranthera*), called *Coreopsis*-1A in their Fig. 5, was not recovered as sister to *Coreopsis* sensu stricto. Their results were in agreement with earlier studies (Kimball et al. 2004, Mort et al. 2008) and support the removal *Electranthera* from *Coreopsis*. Characters used by Candolle (1836), Blake (1913), Sherff (1936), and Mesfin Tadesse and Crawford (2014) to distinguish *Electranthera* (as *Electra* or *Coreopsis* sect. *Electra*) from *Coreopsis* s. str. included its shrubby habit, typically serrate-margined leaves that are never filiform-divided, pistillate ray florets forming fruit (Figs. 1A, 2C), papillose to pilose corolla tubes without a thickened annulus, and strongly flattened, glabrous, obcompressed, non-carbonized cypselae (Figs. 1B–D, 2C). The individual cells of the pericarp epidermis in *Electranthera* have dark secretions on their radial and tangential walls with the epidermis surface slightly raised (Fig. 1D; Type A pericarp surface ornamentation pattern in Mesfin Tadesse and Crawford 2014: Fig. 1C) but are without phytomelanin pegs. Other characters useful in characterizing *Electranthera* include its polarized endothecial tissue typical of Coreopsideae (Fig. 2A) and disk corolla throats with resin ducts single along the veins (Fig. 2B).

In addition to validating *Electranthera* as a replacement name for *Electra* DC. based on the taxonomy of Mesfin Tadesse and Crawford (2014), we propose three new specific and nine new varietal combinations in the genus. We also provide a synopsis of *Electranthera*, supplementing the fine treatments of Sherff (1936), Sherff and Alexander (1955), Crawford (1970, 1981, 1982), Turner (2010), and Mesfin Tadesse and Crawford (2014). We note that Western naming conventions and surnames are not used traditionally in Ethiopia. For example, one of us (Mesfin Tadesse) uses his given name of Mesfin followed by the patronym Tadesse, his name used by IPNI is Mesfin, and his name is spelled in full in literature citations and indexed by the first element.

ELECTRANTHERA Mesfin, Crawford, & Pruski, **nom. nov.** *Electra* DC., Prodr. 5: 630. 1836 (non *Electra* Panz., Ideen Revis. Gräs. 49. 1813, Gramineae). *Coreopsis* sect. *Electra* S.F. Blake, Proc. Amer. Acad. Arts 49: 337. 1913. [the intended sectional comb. nov. by Blake is to be taken as a nom. nov., fide Article 58.1 of the Code]. **TYPE**: *Electra mexicana* DC. [≡ *Electranthera mutica* var. *mexicana* (DC.) Mesfin, Crawford, & Pruski].

Subshrubs to shrubs; stems leafy, leaves more or less evenly distributed distally along branches; herbage eglandular. **Leaves** opposite throughout, undivided to tripartite, sessile to petiolate; blade or blade segments lanceolate to ovate, chartaceous to subcoriaceous or somewhat carnose, venation pinnate, surfaces eglandular, usually glabrous or lightly pubescent to less commonly hirsute or villous, margins serrate or dentate to very rarely entire. **Capitulescence** terminal, open, of several branches each corymbiform-paniculate or with a solitary terminal capitulum, often moderately exserted from subtending leaves on elongate peduncles. **Capitula** radiate, moderately showy; involucre double; phyllaries 2-seriate, dimorphic, unequal to sometimes nearly subequal, more or less planar, free to base; outer phyllaries 4–6, oblanceolate or spatulate to obovate, herbaceous, green, spreading; inner phyllaries ca. 8, usually longer than the outer, more or less ovate-oblong, thin-chartaceous with scarious margins, pluristriate, yellowish with darker striations; clinanthium flat, paleate; paleae flat, few-striate, resin ducts paired, deciduous. **Ray florets** 5–8(–11), pistillate (Fig. 1A); corolla yellow throughout, without dark blotches proximally on limb, tube short, papillose to pilose, limb oblong to elliptic, never obovate-cuneate, 7–15-nerved, resin ducts single long nerves, adaxial surface papillose (Fig. 1A), apex evenly (never obviously irregularly) 2–3(–5)-dentate; style well-exserted. **Disk florets** bisexual, but the innermost sometimes not setting seed; corolla funnelform-campanulate, yellow, (4–)5-lobed, tube usually shorter than to sometimes about as long as throat, papillose to pilose, base not flaring, without a thickened annulus, throat with resin ducts single along veins (Fig. 2B), lobes much shorter than throat, strongly papillose within; anther thecae dark brown to black, filaments glabrous, endothecial pattern polarized (Fig. 2A), collar longer than basal auricles, apical appendage mostly tan but sometimes with proximal central dark resin canal; style branches flattened, appendiculate, stigmatic surfaces (moderately) 2-banded, appendage short cuspidate-subulate or caudate; nectary tubular or narrowly cylindrical. **Cypselae** strongly obcompressed (Figs. 1B–D, 2C), flat to somewhat incurved, erostrate, graduated monomorphic or slightly heteromorphic with ray cypselae and outer disk cypselae broadly elliptic to broadly ovate or obovate in outline, grading to successively longer and narrower inner disk cypselae, these lanceolate or linear-fusiform and sometimes not always setting seed, all cypselae narrow-margined or thinly and narrowly winged, glabrous throughout, faces brown to grayish-black at maturity, nitidous, few-several costate but otherwise smooth, never tuberculate roughened, pericarp surface pattern Type A with the individual cells with dark secretions on their radial and tangential walls (Fig. 1D; Mesfin Tadesse and Crawford 2014: Fig. 1C), but without phytomelanin pegs, base broad-rounded with an inconspicuous carpopodium, carpopodium never thickly globose-calloused (thus not resembling tickseeds), margins entire, stramineous or brown, apex emarginate; all epappose or some inner cypselae very infrequently with a pair of small slender awns. x = 14.

Electranthera is centered in the highlands of Mexico and contains the same three species recognized in *Electra* by Mesfin Tadesse and Crawford (2014): diploid cuneate-leaved *E. cuneifolia*, octoploid small-leaved *E. parvifolia*, and the tetraploid or octoploid (and perhaps occasionally hexaploid) mostly linear-lanceolate to ovate-leaved plants that constitute the remaining bulk of the genus, which we recognize as *E. mutica* and within which we recognized ten moderately distinct varieties. Although, Turner (2010) elevated *E. mutica* var. *multiligulata* to specific rank, we find that this variety falls within our admittedly broad concept of *E. mutica*.

Key to species of *Electranthera*

1. Leaves undivided to 3-parted to near midrib, blades (3–)4–16 cm long, blades or blade segments linear-lanceolate to ovate (when ovate then ≥ 3 cm long); capitulescences usually 5–40+-capitulate, corymbiform-paniculate to open-cymose or infrequently monocephalous; tetraploids or octoploids with $2n = 4x = 56$ or $2n = 8x = 112$, never diploids ..... 2. **Electranthera mutica**
1. Leaves undivided, blades mostly 1–4(–5) cm long, cuneate to oblanceolate or ovate (when ovate then ≤ 2.5 cm long) to orbicular; capitulescences monocephalous to paucicephalous open-cymose; diploids or octoploids with $2n = 2x = 28$ or $2n = 8x = 112$, never tetraploids.

    2. Leaf blades cuneate to oblong or oblanceolate; subshrubs or shrubs 0.5–1 m tall; capitula 14–30 mm wide across the extended rays; southern Durango and Jalisco, Mexico; diploids with $2n = 2x = 28$ ..... 1. **Electranthera cuneifolia**
    2. Leaf blades ovate to orbicular; shrubs mostly 1–3 m tall; capitula 25–45 mm wide across the extended rays; eastern Puebla and west-central Veracruz, Mexico; octoploids with $2n = 8x = 112$ ..... 3. **Electranthera parvifolia**

1. **ELECTRANTHERA CUNEIFOLIA** (Greenm.) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis cuneifolia* Greenm., Proc. Amer. Acad. Arts 40: 43. 1904. *Electra cuneifolia* (Greenm.) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **LECTOTYPE** (as to collection by Blake et al. 1926: 1587; second step sheet designation by Sherff 1936: 301): **MEXICO. Durango.** Without specific locality, 16 Aug 1897, *Rose 2344* (lectotype: GH; isolectotype: US). McVaugh (1984: 256) cited US as the lectotype sheet. Figure 3.

Subshrubs or shrubs 0.5–1 m tall; stems few-branched, sparsely villosulous to villous at the nodes, otherwise glabrate; internodes as seen on herbarium specimens often about as long as or shorter than the leaves. **Leaves** undivided, subsessile to petiolate; petiole 0.1–0.5 cm long; blade mostly 1–4(–5) × 0.5–2(–2.5) cm, cuneate to oblong or oblanceolate, subcoriaceous to somewhat carnose, secondary veins usually 2–4(–5) per side, surfaces glabrous or sometimes sparsely puberulent, base narrowly cuneate to long-acuminate, margins distally few-serrate, teeth 1–5 per side, 1–2 mm long, spreading, apex usually acute. **Capitulescence** monocephalous to paucicephalous open-cymose; peduncles 5–20 cm long, costate-angulate. **Capitula** 8–11 mm tall, 14–30 mm wide across the extended rays; involucre 5–10 mm long, campanulate; outer phyllaries 4–5, 3–6.5 × 1.2–1.7 mm, narrowly oblong, much narrower than and ca. 1/2–3/4 as long as inner phyllaries, appressed to slightly spreading, subcarnose, green, 3-nerved, lateral nerves submarginal, glabrous, not contiguous at base, apex acute to obtuse; inner phyllaries 5–10 × 3–3.8 mm, obovate, scarious, yellowish with 7–9 dark nerves, margins pale-hyaline, apex broadly acute to obtuse; paleae ca. 10 mm long, linear-lanceolate, 3-nerved, glabrous, apex broadly acute. **Ray florets** usually 5(–6); corolla limb 6–15 mm long, obovate to suborbicular, 8–12-nerved, apical teeth to 2 mm long. **Disk florets** 15–25(–30); corolla 4.3–4.8 mm long, lobes ca. 0.9 mm long; anthers ca. 2 mm long; style branches ca. 1.3 mm long, sterile appendage 0.3–0.4 mm long. **Cypselae** 6–9 × 3–5.5 mm, broadly elliptic to obovate in outline; epappose or infrequently a few inner ones with 2 narrow fragile awns about as long as disk corollas.

Representative collections. **MEXICO. Durango.** *Rose 2344* (lectotype collection: GH, US). **Jalisco.** *Barnes & Land 165* (F, MO); *Melchert et al. 6358* (MO, OS); *Pringle 8781* (syntype collection: CM, E, GH, GOET, K, MEXU-4, MIN, MO, NY, P, PH, S, VT); *Pringle 11900* (F, GH).

Distribution, elevation, and chromosome number. *Electranthera cuneifolia* is known only from southern Durango and Jalisco in western Mexico (as mapped by Turner 2010: 154, map 33), where it occurs mostly in oak forests from 1500–1800 meters elevation; diploid, $2n = 2x = 28$.

This is the only species of *Electranthera* treated by McVaugh (1984) in Nueva Galicia.

Figure 3. Syntype of *Coreopsis cuneifolia* (≡ *Electranthera cuneifolia*) (*Pringle 8781*, MO).

2. **ELECTRANTHERA MUTICA** (DC.) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* DC., Prodr. 5: 571. 1836. *Electra mutica* (DC.) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO.** Ad Tlapujahua [precise locality uncertain, perhaps Hidalgo?, Michoacán border with Mexico?, or Puebla?], comm. 1829, *Keerl s.n.* (holotype: BR-MART; isotypes: F, G-DC p.p.). The G-DC isotype is a labeled packet on the bottom of the sheet, as well as a branchlet matching the BR branchlets. The F fragment from G-DC is presumably from this packet and is an isotype of the typical variety. Mesfin Tadesse and Crawford (2014: 88) cited G-DC as the lectotype specimen, but this conflicts with Candolle's protologue that gave "v.s. in h. Mart." Indeed, Sherff (1936) cited correctly the holotype in the personal Martius herbarium now housed in the Botanic Garden in Meise, cited by us as BR-MART.

Turner (1992) noted that Keerl's place name Tlapujahua is in extreme eastern Michoacán (less than 10 km west of border with Edo. Mexico), but the species is otherwise unknown in the environs of Tlapujahua. Sherff (1936) and Mesfin Tadesse and Crawford (2014) interpreted the Keerl place name as Tlapacoya, Puebla, a locality about 250 km east of Tlapujahua, Michoacán, but the species is otherwise unknown from near Tlapacoya in north-central Puebla. Sherff and Alexander (1955) gave (incorrectly) the type locality as "Tlapehula, Guerrero?" but only one rare non-typical endemic variety is known from Guerrero. Because the species appears unknown or at best very rare near Tlapujahua (Michoacán border with Mexico), Tlapacoya (Puebla), and Tlapehula (Guerrero), it seems possible that Keerl's plants may have come from elsewhere. Indeed, based on the specimens in front of us and the exsiccate citations and maps in Crawford (1970, 1981) it seems plausible that Keerl's plants may be from southern Hidalgo (or adjacent Puebla), where *E. mutica* var. *mutica* sensu Crawford (1970, 1981) is centered.

Shrubs 0.3–5 m tall; stems branched, mostly subglabrous to densely pilose or villous. **Leaves** undivided to 3-parted to near midrib, petiolate or distal ones subsessile; petiole 0.5–3 cm long, narrowly margined distally; blade (3–)4–16 × 1–6 cm, blade or blade segments linear-lanceolate to ovate, thin chartaceous to subcarnose or stiff-chartaceous, usually with several evenly spaced secondary veins, adaxial surface glabrous or subglabrous to infrequently pilose-hirsute, abaxial surface glabrous to occasionally villous especially along larger veins, base attenuate with short basal acumen to cuneate or infrequently somewhat rounded, margins serrate very infrequently subentire, apex acute to acuminate or attenuate. **Capitulescence** usually 5–40+-capitulate, corymbiform-paniculate to open-cymose or infrequently monocephalous, fertile branchlets bracteate, bracts 0.4–1.5+ cm long; peduncles 1–10 cm long, slender. **Capitula** 6–17 mm tall, 20–50 mm wide across extended rays; involucre 6–12 mm long, campanulate or narrowly so; outer phyllaries 4–6, 5–12 × 1–2.5 mm, oblanceolate to obovate, glabrous throughout to villous or margins sometimes ciliate, apex narrowly acute to broadly obtuse, more or less mucronulate; inner phyllaries 5–7(–8), 8–12 mm long, oblong to elliptic or broadly ovate, golden-brown with stramineous margins, dark pluristriate with yellow intercostae very narrow; paleae (6–)8–11 mm long, narrower than inner phyllaries, usually reaching to about middle of corolla throat, narrowly oblanceolate, 3–7-striate, apex acute to obtuse. **Ray florets** 5–8(–11); corolla limb 10–20 × (4–)6–12 mm, elliptic to obovate, 7–15-nerved. **Disk florets** 10–20; corolla 5–7.5 mm long, resin canals of throat dark but sometimes drying with a very thin pale central streak, lobes usually 0.9–1.3 mm long; anthers 2.5–4 mm long; style branches 1.5–2 mm long, sterile appendage 0.3–0.7 mm long. **Cypselae** 5–10(–13) mm long, broadly ovate or elliptic in outline to inner ones sometimes linear-fusiform; epappose or rarely inner ones with 2 small vestigial awns.

Representative collections. Supplementing the below cited type specimens of each variety, respectively, are additional specimen citations as given in Crawford (1970, 1981) and Turner (1992, 1996).

Distribution, elevation, and chromosome numbers. *Electranthera mutica* is centered in Mexico, with only the very common *E. mutica* var. *microcephala* occurring southwards into Central America. Distribution maps for most varieties were provided by Crawford (1970, 1981) and Turner (1992, 2010), showing that six of the ten varieties occur in Oaxaca. The species occurs mostly in montane forests, oak forests, pine-oak forests, and thickets, on dry hillsides, roadside banks, wooded slopes, and along stream sides from (400–)700–2800 meters elevation with flowering concentrated between June and January. The species contains varieties that are either tetraploid or octoploid ($2n = 4x = 56$ or $2n = 8x = 112$; and perhaps an occasional hexaploid with $2n = 6x =$ ca. 84), varieties of the same ploidy level are for the most part allopatric and reproductively isolated in nature but capable of being crossed artificially. For example, Crawford (1972) showed that octoploids *E. mutica* var. *carnosifolia* and *E. mutica* var. *subvillosa* may be crossed. Chromosome numbers and ploidy levels are unknown in three of the varieties.

Sherff (1936) and Sherff and Alexander (1955) each recognized four varieties. We recognize the seven varieties of Crawford (1970) plus another three varieties proposed subsequently by Crawford (1981) and Turner (1992, 1996). Eight of the following ten varieties were recognized under *Electra mutica* by Mesfin Tadesse and Crawford (2014). Of the ten varieties of *E. mutica* we recognize, perhaps *E. mutica* var. *guerreroana* by its undivided entire leaves is the least mainstream. However, *E. mutica* var. *guerreroana* too is provisionally retained within *E. mutica* with the caveat that should it prove to be diploid it would be worthy of specific recognition. Thus in our present concept of *Electranthera*, all material except for infrequently encountered diploid, cuneate-leaved *E. cuneifolia* and octoploid small-leaved *E. parvifolia* falls within tetraploid to octoploid *E. mutica*.

Keys to the varieties of *Electranthera mutica* were provided by Crawford (1970) and Turner (1992, 2010). Crawford's first couplet was based on leaf division, whereas the keys by Turner did not place the same emphasis on this character. We also find leaf division the most useful primary character for conceptualizing infrataxa, and following Crawford (1970) we note that four varieties (vars. *holotricha*, *leptomera*, *mutica*, and *subvillosa*) typically have at least some leaves 3-parted. Among these four 3-parted-leaved varieties, indumentum features serve to diagnose *E. mutica* var. *holotricha* (leaves usually less than 4 cm long, pubescent adaxially) and *E. mutica* var. *subvillosa* (capitulescence branches villous or subvillous), whereas *E. mutica* var. *leptomera* is the only known tetraploid and has terminal lanceolate leaf segments.

The six varieties that are strictly undivided-leaved are *E. mutica* vars. *carnosifolia*, *guerreroana*, *mexicana*, *miahuatlana*, *microcephala*, and *multiligulata*. Although *E. mutica* is usually circumscribed in part by it pluricephalous capitulescences, four of the undivided-leaved varieties (vars. *carnosifolia*, *guerreroana*, *mexicana*, and *multiligulata*) are paucicephalous or even monocephalous. Among the four paucicephalous undivided-leaved varieties, only *E. mutica* var. *guerreroana* has entire-margined leaves. *Electranthera mutica* var. *multiligulata* is diagnosed by its large capitula each with 8–11 ray florets, vs. the usual 5–8-rayed condition of the other nine varieties of *E. mutica* and of the two other species of *Electranthera*. When chromosome numbers and ploidy levels are known, the undivided-leaved varieties of *E. mutica* are generally tetraploids, with *E. mutica* var. *carnosifolia* standing out as the only known octoploid. The two pluricephalous undivided-leaved varieties of *E. mutica* recognized by us (*E. mutica* vars. *miahuatlana* and *microcephala*) are very similar, and *E. mutica* var. *miahuatlana* by its relatively large capitula is recognized by us as distinct from *E. mutica* var. *microcephala*.

The ten varieties of *E. mutica* that we recognize are as follows.

2A. ELECTRANTHERA MUTICA var. **CARNOSIFOLIA** (Crawford) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis mutica* var. *carnosifolia* Crawford, Brittonia 22: 110. 1970. *Electra mutica* var. *carnosifolia* (Crawford) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO. Oaxaca.** Hwy 190, km 689–690, 15.8 mi NW of bridge over Río Hondo and 40.6 mi SE of Totolapan, 15 Sep 1967, *Melchert, Crawford & Averett 67-86* (holotype: IA; isotypes: OS, RM).

Distribution, elevation, and chromosome number. Mexico (Oaxaca; mapped by Crawford 1970: 99, fig. 1); moderately common between (400–)1600–2500 meters elevation; octoploid, $2n = 8x = 112$.

Electranthera mutica var. *carnosifolia* has undivided leaves drying resin-streaked thereby resembling *E. mutica* var. *guerreroana*. Crawford (1972) noted that populations of suspected hybrids between *E. mutica* vars. *carnosifolia* and *subvillosa* occur at about 1500 meters elevation near the city of Oaxaca. Some material from low elevations west of Tehuantepec along the Pacific slope of Oaxaca resembles *E. mutica* var. *multiligulata* by its few-capitulate distal branches but never has 11 rays per capitulum.

2B. ELECTRANTHERA MUTICA var. **GUERREROANA** (B.L. Turner) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis mutica* var. *guerreroana* B.L. Turner, Phytologia 73: 7. 1992. **TYPE: MEXICO. Guerrero.** 6 km E of Chatacachapa, a village between Chilapa and Tixtla along the road to Chilpancingo, 1900 m, 4 Sep 1991, *Panero 2281* (holotype: MEXU; isotypes: MEXU, MICH, TEX, US).

Distribution, elevation, and chromosome number. Mexico (Guerrero; mapped by Turner 2010: 155, map 36), known only from near the type locality; ca. 1500 meters elevation; chromosome number unknown.

We suspect this taxon may prove to be either a tetraploid or an octoploid and thus provisionally retain it at the varietal rank. It stands out, however, as the sole taxon of *Electranthera* with entire-margined leaves. Should the distinctive *E. mutica* var. *guerreroana* prove to be a diploid taxon, however, it would merit specific recognition.

2C. ELECTRANTHERA MUTICA var. **HOLOTRICHA** (S.F. Blake) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis mexicana* fo. *holotricha* S.F. Blake, Proc. Amer. Acad. Arts 49: 338. 1913. *Coreopsis mutica* var. *holotricha* (S.F. Blake) S.F. Blake, Proc. Amer. Acad. Arts 52: 55. 1917. **TYPE: MEXICO. Puebla.** Vicinity of San Luis Tultitlanapa, Jul 1908, *Purpus 3099* (holotype: GH; isotypes: F, MO, NY, UC, US).

Distribution, elevation, and chromosome number. Mexico (Oaxaca, Puebla; mapped by Crawford 1970: 99, fig. 1); uncommon between 1800–2400 meters elevation; chromosome number unknown.

Mesfin Tadesse and Crawford (2014) intended to validate a new combination in *Electra mutica* for this variety but did not cite the basionym *C. mexicana* fo. *holotricha*. Both leaf surfaces of this taxon are moderately to densely pubescent.

2D. ELECTRANTHERA MUTICA var. **LEPTOMERA** (Sherff) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis mutica* var. *leptomera* Sherff, Bot. Gaz. 88: 300. 1929. *Electra mutica* var. *leptomera* (Sherff) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO.**

Hidalgo. Dublan, 6800 ft. [= 2070 m], 15 Oct 1902, *Pringle 9895* (holotype: F; isotypes: B, CM, GH, JE, MO, NY, US).

Silphium ternatum Sessé & Moc., non Willd.

Distribution, elevation, and chromosome number. Mexico (Hidalgo, Jalisco, Mexico, Queretaro; mapped by Crawford 1970: 99, fig. 1, but Guanajuato localities now excluded as in Crawford 1981: 550, fig. 2; nevertheless to be looked for in Guanajuato and northern Michoacán, where Rzedowski and Calderón de Rzedowski (2008) and Turner (2010) listed a broadly defined *E. mutica* var. *mutica* as occurring; the Sessé and Mociño type locality of synonymous *S. ternatum* given as "Tuxtlae montibus" is not known to us, and although McVaugh (2000) suggested it is San Andrés Tuxtla, Veracruz, this is unlikely because the species is otherwise not reported from there); occasional between 1800–2200 meters elevation; tetraploid, $2n = 4x = 56$.

We follow the taxonomy of Crawford (1970) as modified by Crawford (1981), and recognize a narrowly defined tetraploid *E. mutica* var. *leptomera* as distinct from both *E. mutica* var. *mexicana* and the more eastern *E. mutica* var. *mutica* by typically 3-parted leaves with narrowly lanceolate terminal segments.

2E. ELECTRANTHERA MUTICA var. **MEXICANA** (DC.) Mesfin, Crawford, & Pruski, **comb. nov**. *Electra mexicana* DC. [var. *mexicana*], Prodr. 5: 630. 1836 (autonym and varietal priority established by Blake 1913 upon naming of *C. mexicana* var. *hyperdasya*). *Coreopsis mexicana* (DC.) Hemsl. Biol. Cent.-Amer., Bot. 2: 196. 1881. **LECTOTYPE** (designated as to collection by Crawford 1981): **MEXICO. Guanajuato**. Villalpando, 1829, *Mendez & Alaman s.n.* (lectotype, sheet designation made here): G-DC, IDC microfiche 800. 965.I.2, Macbride neg. 33770; presumed isolectotypes: G-DC 2-sheets, GH [the G-DC isotypes are on IDC microfiche 800. 965.I.3 and 965.I.4]). The branches of the lectotype sheet are positioned differently in the microfiche than on the earlier Macbride photograph. The two presumed isolectotypes in G-DC are without collection information, but in the microfiche set they follow immediately the labeled lectotype. The collection information on the GH sheet is in the hand of Asa Gray. Second cited syntype collection: *Nee s.n.* (not seen).

Coreopsis mutica var. *simplicifolia* Crawford, *Electra mutica* var. *simplicifolia* (Crawford) Mesfin & Crawford.

Distribution, elevation, and chromosome number. Mexico (Guanajuato; mapped by Crawford 1981: 550, fig. 2 under the name *C. mutica* var. *simplicifolia*); uncommon narrow endemic at about 2100–2200 meters elevation; tetraploid, $2n = 4x = 56$.

Blake (1917) and Blake et al. (1926) treated *Coreopsis mexicana* (i.e., var. *mexicana*, priority established in 1913) in synonymy with the typical variety of *C. mutica*, whereas Sherff (1936), Sherff and Alexander (1955), and Crawford (1970) treated *C. mexicana* [var. *mexicana*] in synonymy with *C. mutica* var. *leptomera* (1929). Crawford (1970) also provisionally included material from Guanajuato in his concept of *C. mutica* var. *leptomera*. Rzedowski and Calderón de Rzedowski (2008) and Turner (1992, 2010) treated both *Electra mexicana* and *C. mutica* var. *simplicifolia* in taxonomic synonymy with octoploid *C. mutica* var. *mutica*. Crawford (1981) excluded undivided-leaved material from Guanajuato from *C. mutica* var. *mutica*, described this material as *C. mutica* var. *simplicifolia*, and treated heterotypic *C. mexicana* [var. *mexicana*] in taxonomic synonymy with it.

Validation by Blake (1913) of heterotypic *Coreopsis mexicana* var. *hyperdasya* S.F. Blake (a synonym of *E. mutica* var. *subvillosa*), however, established *C. mexicana* var. *mexicana*, the priority

of this autonym thereby dated 1913 as well (viz Article 26.3 of the Code; Turner 1992: 10). Here we follow the taxonomy of Crawford (1981) and thus employ the autonym *C. mexicana* var. *mexicana*, which has priority at varietal rank as the basionym of *E. mutica* var. *mexicana*. We note, however, that while Mesfin Tadesse and Crawford (2014) proposed the name *Electra mutica* var. *simplicifolia* for this taxon, they did not list *Electra mexicana* in synonymy. Tetraploid *E. mutica* var. *mexicana* differs from both octoploid E. *mutica* var. *mutica* and tetraploid *C. mutica* var. *leptomera* by strictly undivided (vs. at least some 3-parted) leaves.

Electranthera mutica var. microcephala
(Crawford) Mesfin, Crawford & Pruski
det. John Pruski (MO), 2014 (PARATYPE)
Taxonomic Studies in the Coreopsideae
Herbarium of The University of Iowa
Coreopsis mutica DC.
var. microcephala Crawford 1969
Daniel J. Crawford
HERBARIUM OF
THE NEW YORK BOTANICAL GARDEN
PLANTS OF MEXICO
Coreopsis mutica DC.
CHIAPAS: In brush along the roadside in oak-forest on limestone mountains; Pan-American highway about 21 road miles east of Tuxtla Gutierrez. Elevation about 3500 feet.
Sprawling shrub 2-3 m. tall. Heads yellow, with mostly 8 rays.
ARTHUR CRONQUIST 9675
October 15, 1962
copyright reserved

Figure 4. Paratype of *Coreopsis mutica* var. *microcephala* (≡ *Electranthera mutica* var. *microcephala*) (*Cronquist 9675*, MO).

2F. ELECTRANTHERA MUTICA var. **MIAHUATLANA** (B.L. Turner) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis mutica* var. *miahuatlana* B.L. Turner, Phytologia 80: 293, fig. 1. 1996. **TYPE: MEXICO. Oaxaca.** Mpio. Miahuatlán, IRF Río Magdalena, Santo Domingo, 2240 m, 4 Aug 1996, *Hinton et al. 26724* (holotype: TEX; isotypes: CIIDIR, GBH, IEB).

Distribution, elevation, and chromosome number. Mexico (Oaxaca; mapped by Turner 2010: 155, map 35); a narrow endemic known from a few collections between 2200–2800 meters elevation; chromosome number unknown.

Although we recognize this variety, further collections may help to better distinguish it from *Electranthera mutica* var. *microcephala*, to which it seems uncomfortably similar, differing primarily by its larger capitula.

2G. ELECTRANTHERA MUTICA var. **MICROCEPHALA** (Crawford) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis mutica* var. *microcephala* Crawford, Brittonia 22: 109. 1970. *Electra mutica* var. *microcephala* (Crawford) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO. Chiapas.** ca. 4 m E of Trinitaria along Route 190, 23 Sep 1966, *Melchert, Sorensen, & Crawford 6453* (holotype: IA; isotype: RM). Figures 1, 2, 4.

Distribution, elevation, and chromosome number. Mexico (Chiapas, Oaxaca) Guatemala, Honduras, El Salvador; mapped by Crawford 1970: 99, fig. 1, we have seen no material from Oaxaca as cited by Turner 2010, but *Breedlove 31451* from Chiapas was collected within 5 km of the border with Oaxaca; fairly common between 800–2400 meters elevation; tetraploid, $2n = 4x = 56$.

Central American material was historically treated within the octoploid typical variety (e.g., Blake et al. 1926; Sherff 1936; Sherff and Alexander 1955) but more recently has been recognized as *E. mutica* var. *microcephala* (e.g., Crawford 1970; Nash and Williams 1976; Strother 1999; Turner 1992, 2010; Mesfin Tadesse and Crawford 2014), a tetraploid taxon.

2H. ELECTRANTHERA MUTICA var. **MULTILIGULATA** (Crawford) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis mutica* var. *multiligulata* Crawford, Brittonia 22: 110. 1970. *Coreopsis multiligulata* (Crawford) B.L. Turner, Phytologia Mem. 15: 75. 2010. *Electra mutica* var. *multiligulata* (Crawford) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO. Oaxaca.** Highway 190, 42 mi W of Tehuantepec, 24 Sep 1966, *Melchert, Sorensen, & Crawford 6469* (holotype: IA; isotypes: OS, RM).

Distribution, elevation, and chromosome number. Mexico (Oaxaca; mapped by Crawford 1970: 99, fig. 1); uncommon narrow endemic from 700–1100 meters elevation; tetraploid, $2n = 4x = 56$.

Electranthera mutica var. *multiligulata* was recognized by Turner (2010) at specific rank but falls within our concept of *E. mutica*, where it is retained at varietal rank. Turner characterized this variety as occurring up to 2200 meters elevation, but we determine material from this elevation as *E. mutica* var. *carnosifolia*. Indeed, tetraploid *E. mutica* var. *multiligulata* seems most similar to octoploid nearly sympatric *E. mutica* var. *carnosifolia*, which differs by having twice the chromosome compliment, often open-cymose (vs. monocephalous) capitulescences, and 8–11-rayed capitula.

2I. ELECTRANTHERA MUTICA (DC.) Mesfin, Crawford, & Pruski var. **MUTICA**.

Distribution, elevation, and chromosome number. Mexico (Hidalgo, México, Michoacán border with Mexico, Puebla; mapped by Crawford 1970: 99, fig. 1; Crawford 1981: 550, fig. 2; Turner 2010: 155, map 36 mapped his broadly defined *E. mutica* var. *mutica* in both Guerrero and Oaxaca, but we have seen no material of *E. mutica* var. *mutica* s. str. from either state); occasional between 2000–2700 meters elevation; octoploid, $2n = 8x = 112$.

Blake (1917), Blake et al. (1926), Sherff (1936), and Sherff and Alexander (1955) each treated *Coreopsis galeottii* in synonymy with the nominate variety, but we follow the taxonomy of Sherff (1936) and Crawford (1970) and treat that name as a synonym of *E. mutica* var. *subvillosa*. Blake (1917), Blake et al. (1926), and Turner (1992, 2010) each treated *C. mexicana* in synonymy with *C. mutica* var. *mutica*, whereas we recognize this undivided-leaved plant as *E. mutica* var. *mexicana*, which is endemic to Guanajuato. The Central American material was treated by Blake et al. (1926) and cited by Sherff (1936) as *C. mutica* var. *mutica* but was described by Crawford (1970) as *C. mutica* var. *microcephala*.

As noted above in the typology of *Electranthera mutica*, the precise protologue type locality of "ad Tlapujahua" (eastern Michoacán on the border with Mexico) is in question. Similarly, Sherff's (1936) interpretation of the type locality of Tlapacoya (Puebla) and the Sherff and Alexander (1955) query of it as being Tlapehula (Guerrero) also reflect uncertainly. We suggest the type locality is from southern Hidalgo (or adjacent Puebla), where Crawford (1970, 1981) mapped this variety as being centered. Although *E. mutica* var. *leptomera*, which also occurs in part in the states of Hidalgo and México, was treated by Turner (1992, 2010) in synonymy with the typical variety, *E. mutica* var. *mutica* differs from it by broader terminal leaf segments. Moreover, the two are disjunct, with *E. mutica* var. *mutica* s. str. occurring only to the east of the range of *E. mutica* var. *leptomera* (Crawford 1981: 550, fig. 2).

2J. ELECTRANTHERA MUTICA var. **SUBVILLOSA** (DC.) Mesfin, Crawford, & Pruski, **comb. nov**.
Coreopsis mutica var. *subvillosa* DC., Prodr. 5: 571. 1836. *Electra mutica* var. *subvillosa* (DC.) Mesfin & Crawford, Nord. J. Bot. 32: 89. 2014 [2013]. **TYPE: MEXICO.** Without specific locality, s.d., *Karwinski s.n.* (holotype: M, Macbride neg. 20711; isotype: G-DC p.p., upper packet).

Coreopsis galeottii (A. Gray) Hemsl., *Coreopsis mexicana* var. *hyperdasya* S.F. Blake, *Electra galeottii* A. Gray.

Distribution, elevation, and chromosome number. Mexico (Oaxaca, Puebla; mapped by Crawford 1970: 99, fig. 1; material cited by Sherff 1936: 299 from Hidalgo has been excluded); moderately common between 1800–2600 meters elevation; octoploid, $2n = 8x = 112$. Turner (1992) reported a count of $2n = 6x =$ ca. 84 for this variety, the only hexaploid we find reported in the genus, but we have not seen Turner's voucher (*Turner 80A-9*, TEX).

We follow Blake (1917), Blake et al. (1926), Sherff (1936), Sherff and Alexander (1955), and Crawford (1970), who synonymized *Coreopsis mexicana* var. *hyperdasya* under *C. mutica* var. *subvillosa*. Blake (1917) and Blake et al. (1926) treated *C. galeottii* in synonymy with the typical variety of *C. mutica*, but we follow instead Sherff (1936) and Crawford (1970) and treat *C. galeottii* in synonymy with *E. mutica* var. *subvillosa*. Hemsley (1881) cited *C. galeottii* (A. Gray) Hemsl. in Guatemala, but all Central American material is determined here as *E. mutica* var. *microcephala*. Thus, *E. mutica* var. *subvillosa* is excluded from Central America.

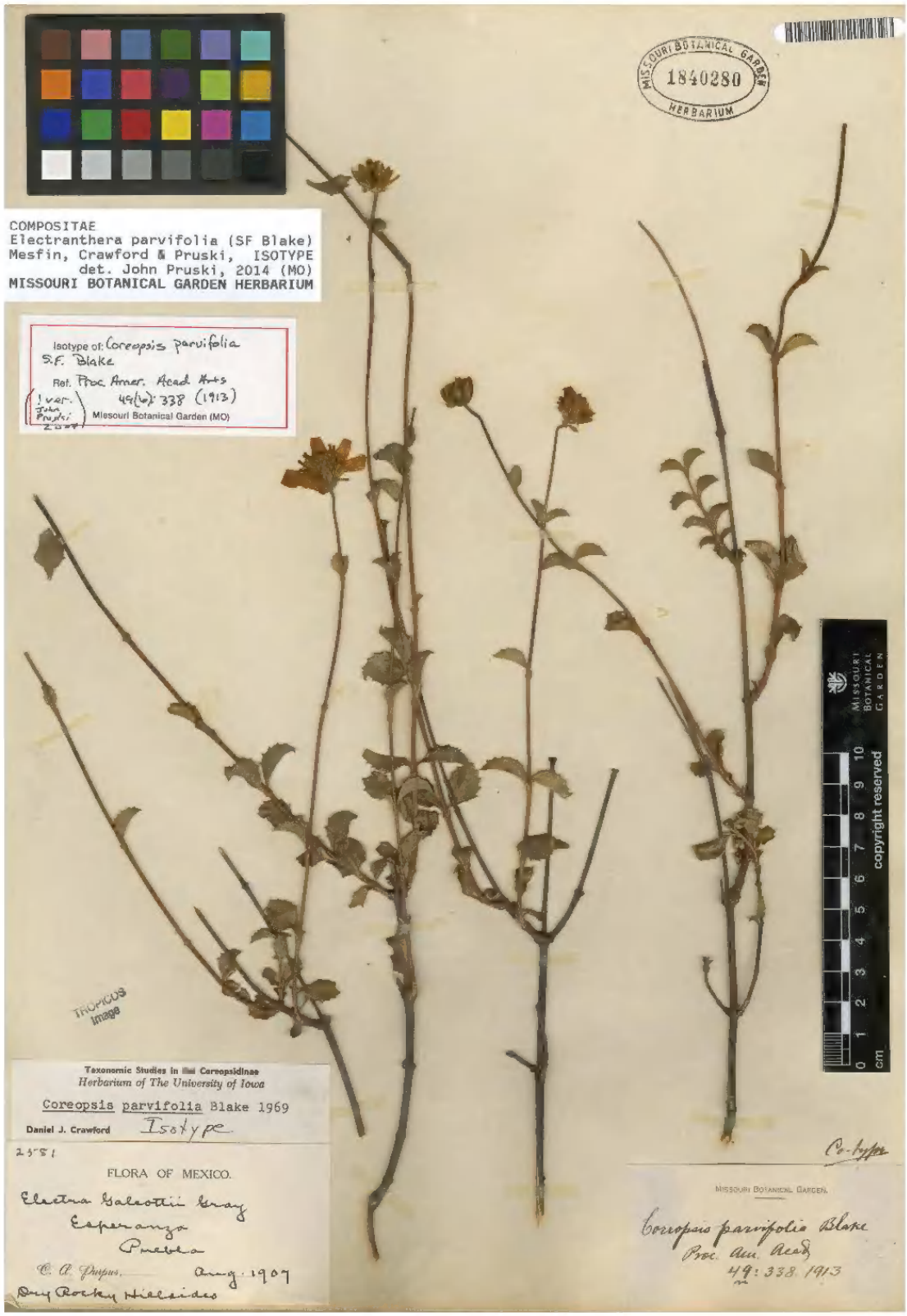

Figure 5. Isotype of *Coreopsis parvifolia* (≡ *Electranthera parvifolia*) (*Purpus 2581*, MO).

3. **ELECTRANTHERA PARVIFOLIA** (S.F. Blake) Mesfin, Crawford, & Pruski, **comb. nov**. *Coreopsis parvifolia* S.F. Blake, Proc. Amer. Acad. Arts 49: 338. 1913. *Electra parvifolia* (S.F. Blake) Mesfin & Crawford, Nord. J. Bot. 32: 89. 2014 [2013]. **TYPE: MEXICO. Puebla.** Esperanza, Aug 1907, *Purpus 2581* (holotype: GH; isotypes: F, MO, NY, UC, US). Figure 5.

Shrubs mostly 1–3 m tall; stems branched, subappressed or antrorse pilose distally, glabrate proximally; distal internodes usually much longer than leaves. **Leaves** undivided, petiolate; petiole 0.2–0.3 cm long; blade mostly 1–2.5 × 0.8–1.5 cm, ovate to orbicular, stiffly subsucculent, secondary veins usually 2–7 per side but not prominent, veins lucidus and sometimes falsely resembling glands, areolae dark, adaxial surface subappressed-puberulent, abaxial surface sparsely villous to glabrous, base cuneate to nearly obtuse, margins 4–5-serrate in distal half, teeth equally spaced, 0.5–1.5 mm long, mostly directed forward, apex broadly acute to obtuse or nearly rounded. **Capitulescence** monocephalous to paucicephalous open-cymose; peduncles 3–10 cm long, costate-angulate. **Capitula** 8–15 mm tall, to 25–45 mm wide across extended rays; involucre 8–11 mm long, campanulate; outer phyllaries 5–6 with 6th perhaps often merely an extreme distal peduncular bracteole closely subtending involucre, 3.9–6 × 1.8–3 mm, narrowly oblong to spatulate, narrower than and ca. 1/2–2/3 as long as inner phyllaries, appressed to slightly spreading, subcarnose, green, 3(–5)-nerved, lateral nerves submarginal, the sublateral veins not as long as laterals and medial, surfaces sparsely villous or more densely so at slightly noncontiguous and somewhat dilated base, margins sometimes ciliate, apex obtuse, sometimes callose-mucronulate; inner phyllaries 8–11 × 2–4.5 mm, obovate, scarious, drying with thin yellowish longitudinal bands between 9–11 pale brownish to reddish broad nerves, margins pale-hyaline, apex mostly obtuse; paleae linear-oblong, 3–5-nerved, glabrous, apex broadly acute. **Ray florets** 5 or 8; corolla limb 12–15 × to ca. 8 mm, ovate to oblong, 11–14-nerved, apex nearly truncate, teeth usually < 0.5 mm long. **Disk florets** 20–25; corolla 6.4–7.4 mm long, lobes 0.9–1.4 mm long; anthers 2.8–3.4 mm long; style branches 1.5–2 mm long, sterile appendage 0.4–0.5 mm long. **Cypselae** 6.5–8 × 2.2–3.2 mm, at least outer ones broadly elliptic to obovate in outline, few-costate; strictly epappose.

Representative collections. **MEXICO. Puebla.** *Crawford et al. 1246* (OS), *1251* (OS); *Dunn et al. 23341* (NY, TEX); *Olsen & Lane 357* (TEX); *Purpus 2581* (type collection: F, GH, MO, NY, UC, US). **Veracruz.** *Carrillo-Reyes y Cházaro 5426* (MO).

Distribution, elevation, and chromosome number. *Electranthera parvifolia* is a locally common narrow endemic known only from a few localities within about 100 km of each other in eastern Puebla and west-central Veracruz in eastern Mexico (basically from near Esperanza north to Cofre de Perote, as mapped in part by Turner 2010: 156, map 37), where it occurs mostly in rocky montane areas and pine-oak forests from 2300–2900 meters elevation; octoploid, $2n = 8x = 112$.

The outer phyllaries, ray corollas, paleae, and disk corollas of *Electranthera parvifolia* were illustrated as *C. parvifolia* by Mesfin Tadesse et al. (1995: figs. 1L, 2G, 3I, and 4B), with their illustration voucher being *Crawford 1251*; the same collection served as a voucher in Crawford (1982) and Mesfin Tadesse and Crawford (2014).

EXCLUDED NAME

Coreopsis buchii (Urb.) S.F. Blake, Contr. U.S. Natl. Herb. 22: 641. 1924 ≡ **Selleophytum buchii** Urb. (see Mesfin Tadesse and Crawford 2006).

ACKNOWLEDGEMENTS

We thank Gerrit Davidse for bringing the name *Electra* Panz. to our attention, Craig Freeman, Guy Nesom, and Rosa Ortiz for helpful comments on the manuscript, and Stephanie Keil and Wendy Westmoreland for their photographs of the herbarium specimens.

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